

**BRITISH SOCIETY
FOR THE
STUDY OF ORTHODONTICS**

1966/7



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Transactions of the
BRITISH SOCIETY FOR THE
STUDY OF ORTHODONTICS

1966/7

HEADQUARTERS

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The following are particularly required for the Society's collection:—

1. Orthodontic appliances that have been in common use in the past.

2. Orthodontic instruments from the past.

3. Series of models, preferably from birth to adulthood, of untreated cases. Normal occlusions would be particularly welcome, as would copies of cephalometric records.

4. The Chapman Collection (Northcroft classification):—

a. Large labial fraenum.

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c. Total anodontia.

d. Delayed eruption due to general conditions.

Complete submergence of deciduous teeth.

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f. Rotation of premolars.

g. Inversion of unerupted upper central incisors and lower first permanent molars.

h. Crowding of incisors or premolars.

i. Infraclusion of deciduous molars.

j. Malrelationship of dental arches, illustrated by study models, cephalometric and photographic records.

k. Examples showing early loss of upper deciduous molars, permanent incisors, and first permanent molars, preferably before and after the loss.

l. The effects of traumatic injury, if possible showing the condition before injury.

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The Honorary Editor is pleased to advise at any stage in the preparation of an article. While in the case of a dispute the ruling of the Honorary Editor should be regarded as final, the author may, if he feels the decision to be unfair, refer the matter to the Council of the Society.

LIST OF MEMBERS

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Clinch, Dr. L. M., 3, Fitzwilliam Place, Dublin, Eire.
Rix, R. E., 40, Harley Street, W.1.

Rushton, Professor M. A., 'Akala', Kippington Lane, Sevenoaks, Kent.
Townend, B. R., 8-9, West Street, Hambledon, Portsmouth, Hampshire.

LIFE MEMBERS

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Caseley, Miss R., 2, Hillside, Whitchurch, Nr. Pangbourne, Berkshire.
Downing, J., Maple, Manor Road, Oadby, Leicestershire.
Eady, B., Maribar, East End Way, Pinner, Middlesex.
Hayton-Williams, D. S., 3 Bladon Close, Oxford, Oxfordshire.

Hudson, J. A., 'Newlands', 13, Russell Road, Moor Park, Northwood, Middlesex.
Leatherman, G. H., 35, Devonshire Place, W.1.
Newton, S. B., Brooklands, 370, Uxbridge Road, Acton Hill, W.3.
Page, G. Scott, 65, Mount Ephraim, Tunbridge Wells, Kent.

ORDINARY MEMBERS

Abbey, R. A., 15, Arundel Road, Eastbourne, Sussex.
Adam, K. W., The White House, Belmont Street, Bognor Regis, Sussex.
Adams, C. P., Orthodontic Department, Royal Victoria Hospital, Belfast, Northern Ireland.
Adams, Miss S., 79, Harley Street, W.1.
Alexander, J. M., The Gateway, Langport, Somerset.
Alexander, Mrs. M., 48, Bracken Hill, Burncross, Chapelton, Sheffield, Yorkshire.
Alexander, S. H., 48, Bracken Hill, Burncross, Chapelton, Sheffield, Yorkshire.
Allan, F., 64, Harley Street, W.1.
Allcorn, A. G. T., 7, Ocklynge Avenue, Eastbourne, Sussex.
Anderson, H. A., 4, Clifton Place, Sauchiehall Street, Glasgow, C.3, Scotland.
Andrew, Miss E. M., 19, Hillcrest Road, Bramhall, Cheshire.
Angelman, J., 37, Upland Road, Eastbourne, Sussex.
Archibald, W. C., 125, Nethergate, Dundee, Scotland.
Ardouin, D. G. F., 'Loan Oak', Sheepstreet Lane, Etchingham, East Sussex.
Arnheim, Miss E. E., 'Dunmore', 12, Hermon Hill, Wanstead, E.11.
Aron, B. D., 19, Hope Road, Prestwich, Manchester, Lancashire.
Atherton, J. D., 17, Mentmore Road, Liverpool, 18, Lancashire.
Attenborough, J. L., 52, Lucknow Drive, Mapperley Park, Nottingham, Nottinghamshire.
Audsley, C. W., Denbigh House, George Street, Ryde, Isle of Wight.
Bailey, J. C., 16, Castle Hill, Maidenhead, Berkshire.
Baker, A., 11, Church Crescent, Dumfries, Scotland.
Baker, C. D., 15, Donnington Road, Kenton, Middlesex.
Baldwin, Miss B. J., 62A, Cheam Road, Sutton, Surrey.
Ballard, Prof. C. F., Eastman Dental Hospital, Gray's Inn Road, W.C.1.
Bane, B., 322a, North End Road, S.W.6.
Barker, D., Wain Cottage, Love Lane, Eastbourne, Sussex.
Barnett, J. D. W., 11, Sylvan Avenue, Exeter, Devon.
Barrie, W. J. McK., Children's Department, Edinburgh University Dental School, 31, Chambers Street, Edinburgh, Scotland.
Bass, N., 44, Harley Street, W.1.
Bass, T. P., 11, Dartmouth Hill, Greenwich, S.E.10.
Beaton, A. G., 67, High Street, Aylesbury, Buckinghamshire.
Belcher, R. J., 'St. Michaels', 111, Bell Street, Reigate, Surrey.
Bell, J. A., Springfield, Pangbourne Hill, Pangbourne, Berkshire.
Bell, R. S., 1, Portland Terrace, The Green, Richmond, Surrey.
Bennett, D. T., 'Escomb', Painshaw Field Road, Stockfield upon Tyne, Northumberland.
Benzies, P. M., Scunthorpe and District War Memorial Hospital, Cliff Gardens, Scunthorpe, Lincolnshire.
Beresford, J. S., 21, Upper Wimpole Street, W.1.
Bergman, R., 1, Sneath Avenue, N.W.11.

Berman, M., 57, Portland Place, W.1.
Bernard, W. E., Pretoria House, 72, Fore Street, Saltash, Cornwall.
Berry, D. C., The Dental Hospital, Lower Maudlin Street, Bristol, 1, Gloucestershire.
Bigg, Miss F. J., 12, Windfield Estate, Epsom Road, Leatherhead, Surrey.
Bird, Mrs. E., 388, Upper Richmond Road, S.W.15.
Bird, E. J. R., 25, Upper Wimpole Street, W.1.
Bird, R. G., St. Mary's Croft, Chapel Field North, Norwich, Norfolk.
Birkinhead, B., 84, Rodney Street, Liverpool, 1, Lancashire.
Black, A., 13, Mount Street, Battle, Sussex.
Bligh, A. J., Annesley, Queen's Road, Crowborough, Sussex.
Blyth, P. J., 10, Lansdowne Place, Clifton, Bristol 8, Gloucestershire.
Boa, J. T., 74, Wordsworth Drive, North Cheam, Surrey.
Bodenham, R. S., The Dental Hospital, St. Mary's Row, Birmingham 4, Warwickshire.
Bonnar, Miss E. M., 4, Elmwood Avenue, Belfast 9, Northern Ireland.
Booth, Mrs. J. H., Owens Park, 293, Wilmslow Road, Fallowfield, Manchester, 14, Lancashire.
Booth, M. H., 67, Thorne Road, Doncaster, Yorkshire.
Bowen, Lieut-Col. E. J., Stuart Lodge, Knollys Road, Aldershot, Hampshire.
Boyd-Cooper, B., 11, Watford Road, Kings Langley, Hertfordshire.
Bradley, P. E., Cedar Hill, Littlebourne, Canterbury, Kent.
Bransby-Zachary, G. M., 103, Brighton Road, Sutton, Surrey.
Breach, Mrs. J. J., 27, Crescent Court, Park Hill, S.W.4.
Breakspear, E. K., 9, St. Andrews Road, Earlsdon, Coventry, Warwickshire.
Brearley, Mrs. H. E., 47, Burnham Court, Moscow Road, W.2.
Brenchley, M. L., Crankill, Ballymena, Co. Antrim, N. Ireland.
Brien, A. B., 131a, Balham High Road, S.W.12.
Briggs, C. P., 47, Arlington Avenue, Leamington Spa, Warwickshire.
Broadway, E. S., 3, Thornely Drive, Ipswich, Suffolk.
Broadway, R. T., 'Tanglewood', Oliver's Battery Road, Winchester, Hampshire.
Brown, K. H., 18, South Terrace, Littlehampton, Sussex.
Brown, W. A. B., Dental School, University of Wales, Heath, Cardiff, Glamorgan, Wales.
Buchan, A., 194, Ferry Road, Edinburgh 6, Scotland.
Buckley, L. A., 'Redmayne', 210, New London Road, Chelmsford, Essex.
Bull, C. C., The Gables, 8, Welholm Road, Grimsby, Lincolnshire.
Bulow, C. F. H., 20, Cedar Road, Sutton, Surrey.
Bunker, D. G., 17a, High Street, Biggleswade, Bedfordshire.

- Burke, P. H., Addenbrookes Hospital, Hills Road, Cambridge, Cambridgeshire.
- Burley, M. A., The Dental and Oral Surgery Dept., South Devon and East Cornwall Hospital, Greenbank Road, Plymouth, Devon.
- Burnapp, D. R., 'Arcadia', Outwood Lane, Chipstead, Surrey.
- Burston, Dr. W. R., 27, Howbeck Road, Oxten, Birkenhead, Cheshire.
- Bush, P. G., 40, Bertram Drive, Meols, Wirral, Cheshire.
- Butler, F. H., 9a, Hill Avenue, Amersham, Buckinghamshire.
- Campbell, A. Courtney, 75, Lichfield Street, Hanley, Stoke-on-Trent, Staffordshire.
- Campbell, Alan C., 40, Harley Street, W.1.
- Campbell, R. A., c/o Regional Dental Office, Ministry of Health, 41, Tothill Street, S.W.1.
- Campbell-Wilson, Miss M., 30, Henleaze Gardens, Westbury-on-Trym, Bristol, Gloucestershire.
- Campion, P. C. S., 61, Wimpole Street, W.1.
- Carpenter, I. P. D., Tangle Trees, Pine Grove, Chichester, Sussex.
- Carr, A. S., Longford House, 9, Sidney Road, Staines, Middlesex.
- Carvalho, Mrs. E. M., 3, Springfield Road, N.W.8.
- Catchside, J., 2, Queen's Parade, Bath, Somerset.
- Chamberlain, G. H., 434, Narborough Road, Leicester.
- Chapman, Mrs. P. A., Sherbroke, Barroldswich, Via Colne, Lancashire.
- Chmielewski, J. K., 165, Pitshanger Lane, W.5.
- Christian, G. C., 6, Dartford Road, Sevenoaks, Kent.
- Christy, D. F., 4, Scotland Bridge Road, New Haw, Weybridge, Surrey.
- Churchyard, R. C., 31, Lloyds Chambers, Cornhill, Ipswich, Suffolk.
- Clark, W. J., 142, Cleveden Road, Glasgow, W.2, Scotland.
- Clarke, N. F., 140, Harley Street, W.1.
- Clifford, E. J. S., 84, Rodney Street, Liverpool, 1, Lancashire.
- Clough, E. O., 54, Hadleigh Road, Leigh-on-Sea, Essex.
- Cockburn, A., The Dental Hospital, 211, Renfrew Street, Glasgow, C.3, Scotland.
- Coker, F. L., Keay House, Town Square, Basildon, Essex.
- Collins, R. A., Farthings, 51, Babylon Way, Ratlon, Eastbourne, Sussex.
- Connolly-Meagher, T. A., Slievenamon Road, Thurles, Co. Tipperary, Ireland.
- Cook, J. T., Orthodontic Department, General Hospital, Ayresome Green Lane, Middlesbrough, Yorkshire.
- Cookson, A. M., Royal Victoria Hospital, Shelley Road, Boscombe, Bournemouth, Hampshire.
- Corfe, R. J. H., Combe Hill House, Whiston, Northamptonshire.
- Cousins, A. J. P., Cathedral Road, Cardiff, Glamorgan-shire, Wales.
- Coyle, Miss N. M., 141, Epsom Road, Guildford, Surrey.
- Coyle, P. R. W., Gayton Littlefield, Bishopsteignton, Teignmouth, Devon.
- Crabb, J. J., 10, Highfield Drive, Sutton Coldfield, Warwickshire.
- Crawford, J. F., 73, Lancaster Road, St. Albans, Hertfordshire.
- Crease, J. A., 'Laurelhurst,' Tenterden, Kent.
- Crossman, I. G., 24, Weald Rise, Haywards Heath, Sussex.
- Crowther-Kemp, Mrs. J. M., 7, Freeland House, Silverdale Road, Eastbourne, Sussex.
- Cruickshank, A. J., 48, King Street, Manchester 2, Lancashire.
- Cryer, B. S., 105, Lynton Mead, Totteridge, N.20.
- Cullingford, J. T. Powell, 14, West Terrace, Eastbourne, Sussex.
- Dagger, T., Parabola House, Cheltenham, Gloucestershire.
- Dallas, H. A., 5, Kensington Park, Bangor, Co. Down, Northern Ireland.
- Davidson, I. F., Orthodontic Department, Denta Unit, Royal South Hants Hospital, Southampton, Hampshire.
- Davis, Mrs. M. E. H., 3, Ascot Road, Moseley, Birmingham 13, Warwickshire.
- Day, A. J. W., 17, Portland Road, Edgbaston, Birmingham 15, Warwickshire.
- Delaney, C. J., 26, Parklee Drive, Carmunnock, Glasgow, Scotland.
- Di Biase, D. D., 42, Hornbeam Road, Theydon Bois, Essex.
- Dickson, G. C., Orthodontic Department, Royal Portsmouth Hospital, Portsmouth, Hampshire.
- Dickson, W. L., 302, Broadwater Crescent, Stevenage, Hertfordshire.
- Dimock, J. R., Redlingtons, Silver Street, Enfield, Middlesex.
- Dixon, D. A., 6, Nicholas Avenue, Whitburn, Sunderland, Co. Durham.
- Dockrell, Dr. R. B., 3, Fitzwilliam Place, Dublin, Eire.
- Dodd, Miss J. M., 7, Thornfield Road, Bishop's Stortford, Hertfordshire.
- Doran, S. K., 36, Holders Hill Road, N.W.4.
- Down, G. R., 58, Peppercombe Road, Eastbourne, Sussex.
- Dumbrell, Miss J. M., Greenlands, Sheringham, Norfolk.
- Eagland, M. C., Brafild Road, Horton, Northampton.
- Edmonds, W. H., Buckingham House, Graham Road, Great Malvern, Worcestershire.
- Edworthy, S. W., 13, Mount Street, Battle, Sussex.
- Eirew, H. L., 307, Wilmslow Road, Fallowfield, Manchester 14, Lancashire.
- Ellis, D. S., 83a, High Street, Gillingham, Kent.
- Ellisdon, P. S., 27, Osgood Avenue, Orpington, Kent.
- Emery, B. J., Glencairn, 73, Orton Lane, Wombourne, Wolverhampton, Staffordshire.
- Endacott, D. J., 4, Rockingham Road, Mannamead, Plymouth, Devon.
- Endicott, C. L., 22, Harcourt House, 19, Cavendish Square, W.1.
- England, Mrs. M., 15, Elm Road, Wantage, Berkshire.
- Evans, Miss L. G., Newlands, 54, Postley Road, Maidstone, Kent.
- Evans, W. D. P., Tynlon, Rhydyfelin, Aberystwyth, Cardiganshire, Wales.
- Everard, G. D., Church Farm, Frampton-on-Severn, Gloucestershire.
- Fanner, M. H., Beauchamp House, 100, The Hundred, Romsey, Hampshire.
- Fawcett, Mrs. A., 64, New Park Street, Devizes, Wiltshire.
- Finkel, W., 561, Green Lanes, Palmers Green, N.13.
- Finn, S. D., 21, Lower Baggot St., Dublin 2, Eire.
- Fitzgerald, G. M., 28, Merrion Square, Dublin, Eire.
- Fletcher, G. G. T., Orthodontic Department, Eastman Dental Hospital, Gray's Inn Road, W.C.1.
- Foster, B. A., 35, Bridge Street, Belper, Derbyshire.
- Foster, Colonel E. S., c/o Q. A. Military Hospital, Millbank, W.1.
- Foster, P. L., 35, Bridge Street, Belper, Derbyshire.
- Foster, T. D., Orthodontic Department, The Dental Hospital, St. Mary's Row, Birmingham 4, Warwickshire.
- Foxton, D., 15a, Commercial Street, Hereford, Herefordshire.
- Frankland, W., 88, Mansfield Road, Nottingham, Nottinghamshire.
- Franklin, Mrs. J. A., 109a, Hare Lane, Claygate, Esher, Surrey.
- Franks, Miss F. L., c/o Barclays Bank, 36, Milsom Street, Bath, Somerset.
- Fraser, A., 21, Newland Road, Banbury, Oxfordshire.
- Frazer, Mrs. J., 5, Pendragon, Lister Lane, Bradford 2, Yorkshire.
- Freeman, H. D., 57, Harley Street, W.1.
- French, J. H., 6, Silver Street, Southsea, Portsmouth, Hampshire.
- Friend, Mrs. D. J., The Old Rectory, Lichfield Road, Stone, Staffordshire.
- Frischmann, I., 215, Tolworth Rise, Surbiton, Surrey.

- Fry, J. C., 17, Upper Wimpole Street, W.1.
 Fulstow, E. D., 87, Love Lane, Pinner, Middlesex.
 Furness, M. J., 3, Ingleby Way, Wallington, Surrey.
 Gardiner, J. H., Orthodontic Department, Charles Clifford Dental Hospital, Wellesley Road, Sheffield 10, Yorkshire.
 Gibson, A. C. L., Edinburgh Dental Hospital, Edinburgh, Scotland.
 Glass, D. F., 4, Elwick Road, Ashford, Kent.
 Glover, E. A., Rectory House, 40, Epsom Road, Guildford, Surrey.
 Godfrey, O. Harcourt, Croft House, Bourne Hill, Salisbury, Wiltshire.
 Godfrey, W. G., Buckingham House, Graham Road, Great Malvern, Worcestershire.
 Golden, A., 16, Dunstan Road, N.W.11.
 Gould, D. G., 4, Wellington Circus, Nottingham, N.G. 5AL.
 Gould, M. S. E., 4, Graeme Road, Enfield, Middlesex.
 Gravely, J. F., Dental School and Hospital, The University, Leeds, 1, Yorkshire.
 Greene, E., 21, Lower Baggot Street, Dublin, 2, Eire.
 Greenfield, D. G., Millbush Farm, East Orchard, Shaftesbury, Dorset.
 Greenwood, A. B., 5, Peter's Place, Brighton, Sussex.
 Greenwood, A. W., 458, Newark Road, Lincoln, Lincolnshire.
 Grice, A. R., Pinewood House, Muster Green, Haywards Heath, Sussex.
 Grieg, W. B. W., 100, Harley Street, W.1.
 Griffith, H. G., 16, College Road, Eastbourne, Sussex.
 Grossmann, W., 79, Harley Street, W.1.
 Halden, J. R., 31, Queen Anne Street, W.1.
 Hall, J. J., St. Ann's Manor, St. Ann Street, Salisbury, Wiltshire.
 Hallet, Prof. G. E. M., 63, Runnymede Road, Darras Hall, Ponteland, Newcastle upon Tyne, Northumberland.
 Halliday, Dr. R. W., 2, The Grove, Woking, Surrey.
 Hardingham, A. J., Charlton House, Cirencester, Gloucestershire.
 Hardy, E. A., 57, Harley Street, W.1.
 Hargreaves, J. A., 60, Cammo Grove, Barton, Edinburgh 4, Scotland.
 Harkness, E. M., Dental School, Heath, Cardiff, Wales.
 Hartley, D. T., Turner Dental School, Bridgeford Street, Manchester 15, Lancashire.
 Harvey, P. D., 22, Norham Gardens, Oxford, Oxfordshire.
 Harwood, W. U., 21, Second Avenue, Hove 3, Sussex.
 Hathaway, R. F., 105, High Street, Billericay, Essex.
 Haynes, S., 8, Queensferry Terrace, Edinburgh 4, Scotland.
 Heffer, P. T., 22, Russell Mansions, 144, Southampton Row, W.C.1.
 Hegarty, Professor M., Department of Orthodontics, Cork Dental Hospital, John Redmond Street, Cork, Ireland.
 Hellier, R. O., 90, Holton Road, Barry, Glamorganshire, Wales.
 Henry, C. Bowdler, 62, Harley Street, W.1.
 Henry, T. Cradock, 8, Upper Wimpole Street, W.1.
 Hewitt, A. B., 5, Priors Road, Hemingford Grey, Huntingdon.
 Heylings, R. T., c/o Hanover House, Batley, Yorkshire.
 Hill, N. L., 69, Northampton Road, Addiscombe, Croydon, Surrey.
 Hilton, R., 293, Windsor Road, Oldham, Lancashire.
 Hobdell, H. G., Dolphin House, South Town, Dartmouth, Devon.
 Hobson, G. S., 10, Elmwood Avenue, Belfast, Northern Ireland.
 Hollick, R. L. B., 17, Portland Road, Edgbaston, Birmingham 15, Warwickshire.
 Holmes, B., 1720, Wimborne Road, Bear Cross, Bournemouth, Hampshire.
 Hood, M. R., 'Laggan', Kilbryde Grove, Dunblane, Perthshire, Scotland.
 Hooper, J. D., Orthodontic Department, Royal Victoria Hospital, Boscombe, Bournemouth, Hampshire.
 Hope, H. D. A., The Briars, St. John's Road, Newbury, Berkshire.
 Hopkin, Dr. G. B., 67, Cluny Gardens, Edinburgh 10, Scotland.
 Hopper, J., 7, Grosvenor Avenue, West Kirby, Wirral, Cheshire.
 Horswill, P. N., Avon House, Amesbury, Wiltshire.
 Horton, J. J., Dene End, Deneside, Eastdean, Eastbourne, Sussex.
 Houston, J. G., 2, Vinicombe Street, Glasgow, W.2., Scotland.
 Houston, W. J. B., 71, Craddocks Avenue, Ashstead, Surrey.
 Hovell, J. H., 92, Harley Street, W.1.
 Howard, R. D., 5, Pope Court, Parkleys, Ham Common, Richmond, Surrey.
 Huddart, A. G., Lyndale, Suckling Green Lane, Codsall, Staffordshire.
 Huggins, D. G., Parkfield, Warrington Road, Hoole, Chester, Cheshire.
 Hughes, F. J., 3, Windsor Crescent, Elderslie, Johnstone, Renfrewshire, Scotland.
 Hughes, H. D. P., 17, Billing Road, Northampton, Northamptonshire.
 Hughes, J. P., 135, Dawson Road, Hyde, Cheshire.
 Hunter, F. W., 4, Cavan Road, Redbourn, Hertfordshire.
 Hutchinson, G. T., 34a, Hans Road, S.W.3.
 Hutton, J. L., 2, Springfield Road, King's Heath, Birmingham 14, Warwickshire.
 Irwin, L. M., 29, High Street, Sandwich, Kent.
 Isaacson, K. G., 6, Oak End Close, Southborough, Tunbridge Wells, Kent.
 Iyer, V. S., The Dental Hospital, Bridgeford Street, Manchester 15, Lancashire.
 Jackson, D., Leeds University Dental School, Blundell Street, Leeds 1, Yorkshire.
 Jackson, Mrs. S. R., Hawthorne House, 18, Chapel Lane, Wilmslow, Cheshire.
 Jadwat, I. A., 'Willington', The Avenue, Camberley, Surrey.
 Jameson, G. D., 12, Southend Avenue, Darlington, Co. Durham.
 Jefferson, Miss C., 6, Draxford Court, Parkway, Wilmslow, Cheshire.
 Jepson, P. D., 'Headingley', Dickinson Avenue, Croxley Green, Hertfordshire.
 Johnson, D. B., The Royal Infirmary, Bradford, 9, Yorkshire.
 Johnson, F. K., Bank House, White Friars, Chester, Cheshire.
 Johnson, J. S., Orthodontic Unit, Booth Hall, Children's Hospital, Charlestown Road, Blackley, Manchester 9.
 Johnson, S., Flat 1, 24, Pembridge Square, W.2.
 Jones, J. E., Gowerdale, Lloyd Street, Llandudno, Caernarvonshire, Wales.
 Kardman, Mrs. F. A., 13, Oakland Road, Bromley, Kent.
 Keith, J. E., 13, Upper Fitzwilliam Street, Dublin, Eire.
 Keniry, A. J., School of Dental Surgery, The Dental Hospital, St. Mary's Row, Birmingham 4, Warwickshire.
 Kennedy, Geo. F., 126, Merion Road, Ballsbridge, Dublin 4, Eire.
 Kerr, G. A., 28, Great North Road, Brookman's Park, Hatfield, Hertfordshire.
 Kerr, Miss M. R., 20, Brook End Drive, Henley-in-Arden, Solihull, Warwickshire.
 Kettle, M. A., 35, Harley Street, W.1.
 Kettle, R. G., 43, High Street, Wimbledon Common, S.W.19.
 Kettler, C. J. R., Flat 3, 31, St. Simon's Road, Southsea, Hampshire.
 Knowles, C. C., Oak Lodge, Windmill Lane, Appleton, Cheshire.
 Kürer, J., 39, Deansgate, Manchester 3, Lancashire.

- Langford, L. F., 12, Standisgate, Wigan, Lancashire.
 Lawton, D. B., 'The Flat', 138, London Road, Sevenoaks, Kent.
 Leech, H. L., Greensleeves, Weedon Lane, Amersham, Buckinghamshire.
 Leighton, B. C., Dental School, King's College Hospital, S.E.5.
 Lester, H., 9, New Church Road, Hove 3, Sussex.
 Levason, J. A., 137, Chatsworth Road, Brondesbury, N.W.2.
 Levison, H., 16, High Park, Stafford, Staffordshire.
 Lewis, A. S., 187, Cathedral Road, Cardiff, Glamorgan-shire, Wales.
 Lewis, E. E., Blandy House, Hart Street, Henley-on-Thames, Oxfordshire.
 Lewis, P. E., 143, Cheam Road, Cheam, Surrey.
 Lindon, Mrs. E. G., 43, The Avenue, St. Margaret's-on-Thames, Middlesex.
 Littlefield, W. H., The Dental Hospital, College Street, Newcastle upon Tyne, Northumberland.
 Logan, W. Russell, 8, Chester Street, Edinburgh 3, Scotland.
 Lovius, B. B. J., The Dental Hospital, Pembroke Place, Liverpool 3, Lancashire.
 Lowenberg, Mrs. B. F., 40, Howard Walk, N.2.
 Luffingham, J. K., 48, Parkstone Avenue, Hornchurch, Essex.
 Lynch, Miss E. M., 146, Holland Park Avenue, W.11.
 McAlpine, A. M., 49, London Road, Tunbridge Wells, Kent.
 McCall, Miss M. C., 12, Swain's Lane, Highgate, N.6.
 McCallin, S. Granger, 57, Portland Place, W.1.
 MacCallum, W. A., Department of Orthodontics, University of Glasgow, 211, Renfrew Street, Glasgow, C.3., Scotland.
 McCartney, T. P. G., The Dental Hospital, Park Place, Dundee, Scotland.
 MacCauley, F. J. L., 129, Castle Avenue, Clontarf, Dublin 3, Eire.
 McCracken, J. G., 33, Higher Bebbington Road, Bebbington, Wirral, Cheshire.
 McDonald, A. A. M., 5, Baillieswells Terrace, Bielside, Aberdeen, Scotland.
 McEwen, J. D., Orthodontic Department, The Dental Hospital, Park Place, Dundee, Scotland.
 McGonigal, F., 5, Snowdon Place, Stirling, Fife, Scotland.
 MacInerney, Miss J., 85, Brook Green, W.6.
 McKane, N. B., 57, Friar Gate, Derby, Derbyshire.
 McKechnie, R., 5, Stanley Avenue, Paisley, Scotland.
 Malik, Miss R., 24, Ellerdale Road, N.W.3.
 Manning, Mrs. J. D., 'Claysands', Pelhams Walk, Esher, Surrey.
 Marsh, W., c/o St. James Hospital, Orthodontic Department, Leeds, Yorkshire.
 Martin, D. W., 15, Arundel Road, Eastbourne, Sussex.
 Martin, H. C., 2A, Chingford Lane, Woodford Green, Essex.
 Martin, J. H., The Dental Hospital, Park Place, Dundee, Scotland.
 Martin, M. D., Buckingham House, Grahams Road, Malvern, Worcestershire.
 Marx, R., 42, Hempstead Road, Watford, Hertfordshire.
 Mason, Mrs. E. M. B., Rhu-ma-Dee, Cults, Aberdeen, Scotland.
 Mayer, J. W., Steadham House, Surbiton Hill, Surbiton, Surrey.
 Mears, Miss R., 37, David Street, Kirkcaldy, Fifeshire, Scotland.
 Metcalf, J., 'Littlefield', 10, Raymond Way, Stevens Lane, Claygate, Surrey.
 Miall, Esq., 5, Braidwood Terrace, North Hill, Plymouth, Devonshire.
 Miles, Prof. A. E. W., London Hospital Medical College, Turner Street, E.1.
 Miller, B. H., 1, Gloucester Crescent, N.W.1.
 Miller, J., 129, Tinsill Road, Leeds 16, Yorkshire.
 Miller, Miss M. N., Dental Clinic, Sighthill Health Centre, Calder Road, Edinburgh 11, Scotland.
 Miller, Mrs. P. S., 47, Gatly Road, Cheadle, Cheshire.
 Mills, Dr. J. R. E., Orthodontic Department, Eastman Dental Hospital, Gray's Inn Road, W.C.1.
 Mizrahi, E., 10, Forest Drive, Timperley, Cheshire.
 Mole, D. O., 'The Gables', 9, St. James's Road, Dudley, Worcestershire.
 Morris, V. B., 64, Beaufort Mansions, Beaufort Street, S.W.3.
 Morse, P. H., 7, Rectory Road, Rickmansworth, Hertfordshire.
 Moss, J. P., 8, Langdon Drive, N.W.9.
 Munday, M. J., 161, Turners Hill, Cheshunt, Hertfordshire.
 Munns, D., 45, St. Andrews Road, Malvern, Worcester-shire.
 Munro, D., The Dental Hospital, Park Place, Dundee, Scotland.
 Murray, Miss J. P., 16, Handley Court, Riverside Road, Aigburth, Liverpool, 19, Lancashire.
 Nelson, J., 40, Epsom Road, Guildford, Surrey.
 Nesbitt, A., 257, Green Lane, Norbury, S.W.16.
 Newell, Major M. J., c/o Westminster Bank Ltd., Park Row, Leeds 1, Yorkshire.
 Nicol, W. A., The Dental Hospital, Lower Maudlin Street, Bristol 1, Gloucestershire.
 Nicolls, J., 233, Selhurst Road, South Norwood, S.E.25.
 Niven, W. N. McL., c/o Ministry of Health, 41, Tothill Street, S.W.1.
 Noar, G. A., 'Carisbrook', Knowsley Road, Whitefield, Manchester, Lancashire.
 Norris, N., 'Balan Farm', Packhorse Lane, Wythall (Kings Norton), near Birmingham, Warwickshire.
 O'Brien, J. D., 27, St. Mary's Road, Market Harborough, Leicester, Leicestershire.
 O'Connor, P. J., 1, Sidney Place, Cork, Eire.
 Ogston, R. D., Maple Lea, Hindhead, Surrey.
 Oliver, D. H., 1, Downes Court, Winchmore Hill, N.21.
 Orton, H. S., Old Elms, 12, Walpole Road, Surbiton, Surrey.
 Page, J., 12, Oak End Close, Southborough, Tunbridge Wells, Kent.
 Panter, Miss A., 35, St. Albans Road, N.W.5.
 Parker, C. D., 11, Carisbrooke Avenue, South Knighton, Leicester, Leicestershire.
 Parr, P. T., Carlton Court, Carlton Drive, S.W.15.
 Parry, H. L., 36, Uplands Crescent, Uplands Square, Swansea, Wales.
 Patel, V. J., 187, Cathedral Road, Cardiff, Glamorgan-shire, Wales.
 Peace, Mrs. H. C., 15, Southmead Road, Westbury-on-Trym, Bristol, Gloucestershire.
 Pearshall, M. L. H., 8, Springfield Park Road, Horsham, Sussex.
 Perks, E. J., Angle House, St. Austell, Cornwall.
 Pettman, J. R., 105, Tunstall Road, Sunderland, Co. Durham.
 Phillips, J. E., 4, Spencer Parade, Northampton.
 Pilbeam, J. F., Cherry Bank, Woodland Way, Bidborough, Tunbridge Wells, Kent.
 Plint, D. A., Royal East Sussex Hospital, Hastings, Sussex.
 Pogrel, H., Grayton, County Road North, Ormskirk, Lancashire.
 Pook, R. S., 19, Wimpole Street, W.1.
 Potokar, S. L., 23, Bramble Drive, Sneyd Park, Bristol 9, Gloucestershire.
 Potts, Miss A., 4, Reigate Avenue, Linthorpe, Middles-brough, Yorkshire.
 Poulter, N. M., Garth, 108, Staplegrove Road, Taunton, Somerset.
 Powell, J. E., 20, Chorley New Road, Bolton, Lancashire.
 Price, A. H. K., Orthodontic Department, Charles Clifford Dental Hospital, Wellesley Road, Sheffield 10, Yorkshire.
 Pringle, K. E., Dental Department, Memorial Hospital, Shooters Hill, S.E.18.
 Ratcliffe, C., 120, Green Lane, Bolton, Lancs.
 Rayne, J., Tudor Lodge, Pusey, Faringdon, Berkshire.
 Reid, D., Sandringham, Guildford Road, Woking, Surrey.

- Reynolds, B. F., Hampton House, 176, London Road, Leicester, Leicestershire.
- Rhodes, A. A., 307, Wilmslow Road, Manchester, 14, Lancashire.
- Rice, V. G., Woodbourne, Knoll Road, Camberley, Surrey.
- Richards, H., 85, Harley Street, W.1.
- Richardson, A., 33, Cherryvalley Park, Belfast 5, Northern Ireland.
- Richardson, Mrs. M. E., 33, Cherryvalley Park, Belfast 5, Northern Ireland.
- Ridley, Miss D. R., Orthodontic Department, Raigmore Hospital, Inverness, Scotland.
- Ritchie, Miss J., 19, Harcourt House, 19, Cavendish Square, W.1.
- Ritchie, J. C., 14, South Street, Romford, Essex.
- Roberts, G. H., Royal Aberdeen Hospital for Sick Children, Westburn Drive, Aberdeen.
- Roberts, Mrs. S., 36, Merrow Chase, Levylsden, Merrow, Guildford, Surrey.
- Robertson, N. R. E., Orthodontic Department, Turner Dental School, Bridgeford Street, Manchester 15, Lancashire.
- Robertson-Ritchie, D., Market House, Market Avenue, Chichester, Sussex.
- Robertson-Ritchie, Mrs. E. L., Market House, Market Avenue, Chichester, Sussex.
- Robinson, S. I. M., 61, Somerset Road, Redhill, Surrey.
- Robinson, Mrs. S. I. M., 61, Somerset Road, Redhill, Surrey.
- Robson, P. S., 11, Yeomans Avenue, Harpenden, Hertfordshire.
- Rogers, D. A., 46, Ickenham Road, Ruislip, Middlesex.
- Rose, J. S., 30, Wimpole Street, W.1.
- Rose, R. J., 22, Grenville Gardens, Birchington, Kent.
- Rubie, G. J., 36, Dartford Road, Sevenoaks, Kent.
- Rumble, J. D., 19, East Cliff, Dover, Kent.
- Rumble, J. F. S., 4, Pembroke Road, Sevenoaks, Kent.
- Russell, L. H., 378, Finchley Road, Hampstead, N.W.3.
- Rydemark, J. E., 8, Devonshire Place, W.1.
- Salter, R. C. P., 149, Kings Road, Westcliff-on-Sea, Essex.
- Sandiford, H. E., Greenhaze, Bowerland Lane, Lingfield, Surrey.
- Sarll, D. W., 146, Broad Street, Salford, Lancashire.
- Savage, M., 31, Beaumont Street, Oxford, Oxfordshire.
- Schachter, H., 115, Harley Street, W.1.
- Scheer, B., 66, Corningham Road, N.W.11.
- Schuller, L. H., 28, Devonshire Place, W.1.
- Sclare, Miss R., 5, Sandhill Drive, Alwoodley, Leeds, Yorkshire.
- Scoones, J. M., 110, St. John's Road, Tunbridge Wells, Kent.
- Scott, M. F., 5, The Armoury, London Road, Shrewsbury, Shropshire.
- Scott, Miss M. K., 73, Home Park Road, Wimbledon, S.W.19.
- Seel, D., The Dental Hospital, Lower Maudlin Street, Bristol 1, Gloucestershire.
- Senior, W. B., 2, St. John Street, Manchester 3, Lancashire.
- Seymour, A. J. H., 20, Crouch Street, Colchester, Essex.
- Shapland, A. F. D., Burnside, 384, Topsham Road, Countess Weir, Exeter, Devon.
- Sharland, R. J., 30, Wimpole Street, W.1.
- Shenton, F. C., Orthodontic Department, Royal Alexandra Hospital, Dyke Road, Brighton 1, Sussex.
- Shepperd, R. V., Dunheved, Pilgrim's Way, West Humble, Dorking, Surrey.
- Sherwood, H., 18, Goodmayes Road, Goodmayes, Essex.
- Shotts, A., 3, Scotch Common, West Ealing, W.13.
- Sider, Mrs. V., 15, Dorfee Avenue, N.W.10.
- Silver, M. M., 27, St. John's Grove, N.19.
- Smith, B. D., 22, Ulster Place, Upper Harley Street, N.W.1.
- Smith, D. I., 22, Ulster Place, Upper Harley Street, N.W.1.
- Smith, K. A., 23, Fosse Road Central, Leicester.
- Smith, T., Carisbrooke, 238, London Road, Leicester.
- Softley, J. W., Woodpeckers, Pangbourne, Berkshire.
- Soul, D. F., 62, Station Road, Chingford, E.4.
- Sperryn-Jones, G., 125, Chertsey Road, Woking, Surrey.
- Standing, R. A., 24, Bore Street, Lichfield, Staffordshire.
- Steadman, B. St. J., 33, Wellington Square, Sloane Square, S.W.1.
- Steel, G. H., 99, Sunderland Road, South Shields, Co. Durham.
- Stephens, P. Maxwell, 17, Upper Wimpole Street, W.1.
- Stephenson, J. C., The Dental Hospital, Lower Maudlin Street, Bristol 1, Gloucestershire.
- Stevenson, Wm., The Threshold, 145, Bo'ness Road, Grangemouth, Stirlingshire, Scotland.
- Still, Miss E. M., Hockett Cottage, Cookham Dean, Berkshire.
- Stobie, C. W., Hillberry, Austenwood Lane, Gerrards Cross, Buckinghamshire.
- Strange, Mrs. M. C., Tower House, Newmarket, Beccles, Suffolk.
- Strauss, K., 107, Deansbrook Road, Edgware, Middlesex.
- Stubley, R., 77, Elmfield Road, Gosforth, Newcastle upon Tyne, 3, Northumberland.
- Sullivan, P. G., 80, Wickham Road, Higham's Park, E.4.
- Swann, A. J., 10, High Street, Chippenham, Wiltshire.
- Swift, P. A., Langsmead, Uxbridge Road, Hayes, Middlesex.
- Tait, R. V., 62, Nightingale Road, Rickmansworth, Hertfordshire.
- Tanner, Mrs. P. M., Quantock, 21, Meadway, Berkhamstead, Hertfordshire.
- Tata, F. R., 10, Sylvester Avenue, Chislehurst, Kent.
- Taylor, A. G., 51, North End House, Fitzjames Avenue, W.14.
- Taylor, Miss B., 6, University Terrace, Belfast 9, Northern Ireland.
- Taylor, B. P., 49, London Road, Tunbridge Wells, Kent.
- Taylor, S. B., 21, Second Avenue, Hove 3, Sussex.
- Telow, T., 240, Albermarle Road, Beckenham, Kent.
- Thomas, R. J., 3, Upper Lemon Street, Truro, Cornwall.
- Thomson, Mrs. C. M., 166, Garscadden Road, Glasgow, W.5., Scotland.
- Thurston, Mrs. A., 51, Dorchester Court, Herne Hill, S.E.24.
- Tibbatts, Mrs. M. A., Monkspath Hill Farm, Stratford Road, Hockley Heath, Solihull, Warwickshire.
- Timms, D. G., Royal Infirmary, Preston, Lancashire.
- Tipnis, A. K., 4, Myddelton Gardens, Winchmore Hill, N.21.
- Titford, K. R., Dalmuir, Gresham Road, Limpsfield, Surrey.
- Tittle, J. J., 4, Red Gabbs Court, White Hill, Bletchingley, Redhill, Surrey.
- Townend, P. I., Evening House, Church Lane, Thursby, Nr. Carlisle, Cumberland.
- Trays, W. N., 3, Downs View, Bude, Cornwall.
- Trend, J. P., 22, Green Dragon Lane, N.21.
- Tulley, Prof. W. J., Dental Department, Guy's Hospital, London Bridge, S.E.1.
- Tupling, L. P., 98, Harley Street, W.1.
- Turner, Mrs. B., M. A., Wayside, 36, Styal Road, Wilmslow, Cheshire.
- Upson, N., 21, Hollingsworth Court, Lovelace Gardens, Surbiton, Surrey.
- Usiskin, L. A., 19, Georgian Court, Vivian Avenue, Hendon, N.W.4.
- Valentine, L. H., 23, St. Georges Road, Cheltenham, Gloucestershire.
- Vaus, K. S., 15, Commercial Street, Hereford, Herefordshire.
- Vig, P., 1, Hillside Gardens, N.6.
- Walker, F. A., 98, Harley Street, W.1.
- Wallis, R., Buckingham House, Graham Road, Malvern, Worcestershire.
- Walther, Prof. D. P., Orthodontic Department, Royal Dental Hospital, Leicester Square, W.C.2.
- Ward, Mrs. A. D., 186, Wricklemarsh Road, S.E.3.

Warner, Miss D. E. M., 19, Downage, Hendon, N.W.4.
 Watkins, B. N., 2, Victoria Street, Stourbridge, Worcestershire.
 Webb, G. H., 26, Albion Street, Hull, Yorkshire.
 Webb, Miss J. M., Mansfield House, Ringwood, Hampshire.
 Webster, Miss E. M., Birnam, 432, Crow Road, Glasgow, W.1, Scotland.
 Welton, Mrs. A. M., Walton, Ryders By, Northall, Dunstable, Bedfordshire.
 West, V. C., c/o Westminster Bank, Bromley South, Kent.
 Westbrook, E. A., 79, Harley Street, W.1.
 White, Miss B. E. E., 40, London Road, Southborough, Tunbridge Wells, Kent.
 White, Prof. T. C., 'Five Acres', Bucklyvie, Stirlingshire, Scotland.
 Whitelegg, J. G., 83, Heathcote Drive, East Grinstead, Sussex.
 Whitfield, P. F. G., 46, Hyde Road, Paignton, Devon.
 Whitling, I. E., Magnolia House, Hankham, near Pevensey, Sussex.
 Whittaker, L. B., 25, Old Orchard Road, Eastbourne, Sussex.
 Widdowson, A. R., 41, Caldby Road, West Kirby, Wirral, Cheshire.
 Wilkie, J. K., 89a, Redland Road, Bristol 6, Gloucestershire.
 Willcocks, R. W., 85, Harley Street, W.1.
 Williams, D. W., Flat 4, 40, Yonge Park, N.W.4.
 Williams, J. K., 67, Thornton Road, S.W.12.
 Williams, T. G. N., 13, Mayfield Road, Albrighton, near Wolverhampton, Staffordshire.
 Wilson, A. J., 84, Rodney Street, Liverpool, 1, Lancashire.
 Wilson, C. P., Chichele House, 42, Kingsley Road, Northampton, Northamptonshire.
 Wilson, H. E., 78, Harley Street, W.1.
 Wilson, R. A., Cranham, 90, Huggetts Lane, Willingdon, Eastbourne, Sussex.
 Winter, G. B., Eastman Dental Hospital, Gray's Inn Road, W.C.1.
 Wongtschowski, K. G., 45, Wimpole Street, W.1.
 Wood, N. J., 2, Clarendon Road, Bournemouth, Hampshire.
 Wood, T. Jason, 241, Manningham Lane, Manningham, Bradford 8, Yorkshire.
 Woods, A. R. H., 4, Manor Place, Edinburgh 3, Scotland.
 Woodward, H. A., 25, East Street, Havant, Hampshire.
 Wraith, Mrs. K. W. L., 1, Jameson Lodge, Shepherd's Hill, Highgate, N.6.
 Wreakes, G., 7, Appledore Crescent, Main Road, Sidcup, Kent.
 Wylde, Mrs. A. S., Churchwood, Fittleworth, Sussex.
 Wynne, T. H. M., Orthodontic Department, Liverpool Dental Hospital, Pembroke Place, Liverpool 3, Lancashire.

CORRESPONDING MEMBERS

Aamodt, A. C., N. Eikervei 35, Drammen, Norway.
 Abensur, Dr. J., Prolg. Benavides 1080-Of. 1, Urb. San Antonio-Miraflores, Lima, Peru, South America.
 Adamson, K. T., 111, Collins Street, Melbourne, Victoria, Australia.
 Ahlgren, Johan, Royal Dental School, Malmö, Sweden.
 Ashby, J. W., Harley, 137, Cambridge Terrace, Christchurch, New Zealand.
 Bakatselos, S., 79, Egnatia Street, Thessaloniki, Greece.
 Bell, L. A., 2437, N. 50th Street, Philadelphia, Pennsylvania, U.S.A.
 Bell, W. P. L., 4, Martin Avenue, Remuera, Auckland, S.E.2., New Zealand.
 Billberg, B., Storgatan 20, Halmstad, Sweden.
 Blausten, Dr. Sam, 253, Main Road, Farmingdale, New York, U.S.A.
 Bowden, B. D., 154, Collins Street, Melbourne, Australia.
 Braude, B., 78, Pasteur Chambers, Jeppe Street, Johannesburg, South Africa.
 Brears, Dr. O. B., Anglo-Ecuadorian Oilfield Ltd., Guayaquil, Casilla 4614, Ecuador, South America.
 Chan, B. K., Government Dental Clinic, Ipoh Perak, Malaysia.
 Cheah, C. K., Y.L. Lee Building, Overseas Union Bank Ltd., 4th Floor, Mountbatten Road, Kuala Lumpur, Malaysia.
 Chohayeb, Dr. Aida, Zeiny Buildings, Maadi, Cairo, Egypt, U.A.R.
 Choo, T. C., Suite E1, 5th Floor, Macdonald House, Orchard Road, Singapore 9, Malaysia.
 Cook, C. C., Queen Street, Masterton, New Zealand.
 Copeland, G. P., 130, Drinkwater Street, Sudbury, Ontario, Canada.
 Coval, Dr. N. M., 30, Westover Place, Lawrence, L.I., N.Y., U.S.A.
 Cox, Dr. N. J., T. & G. Building, 201, Elizabeth Street, Sydney, Australia.
 Crisp, B. C., 217, North Tee, Adelaide, South Australia.
 Croll, Dr. R. O., 620, View Street, Victoria, British Columbia, Canada.
 Demajo, A., 26, Merchants Street, Valletta, Malta.
 Démogé, P. H., 29-33, Avenue Raymond Poincaré, Paris 16e, France.
 De Villiers, J. F., P.O. Box 7668, Johannesburg, South Africa.
 Eastwood, A. W., Faculty of Dentistry, Dalhousie University, Halifax, Nova Scotia, Canada.
 Engh, Olav, Hammerstadgt, 21b, Oslo, Norway.
 Fainsinger, B. E., 1013, Salisbury House, West Street, Durban, South Africa.
 Franklin, G., Medical Building, Drummond Street, Montreal 25, Quebec, Canada.
 Fransblow, P., Georgia Medical-Dental Building, 925, West Georgia Street, Vancouver 1, British Columbia, Canada.
 Freer, T. J., Dental College, University of Queensland, Turbot Street, Brisbane, Australia.
 Gerraty, B. J., 13, Dawson Avenue, Elwood, Melbourne, Australia.
 Ghosh, A. S., 54, Chowringhee, Calcutta, India.
 Gilbert, G. H., Victoria Chambers, 9, Victoria Street, Christchurch, New Zealand.
 Goldstein, M. C., 950, West Peachtree Street, Atlanta, Georgia, U.S.A.
 Gonzalez, R., Pilar 2, Santa Cruz, Tenerife, Canary Islands.
 Gosman, S. D., Orthodontist, 109, South Union Avenue, Margate, New Jersey, 08402, U.S.A.
 Gottlieb, A. W., 44, S. Central Avenue, Valley Stream, New York, U.S.A.
 Granerus, R., Kungssportsavenyen 20, Gothenburg, Sweden.
 Granse, K. A., Mariédalsvagen 25, Malmö, Sweden.
 Grossman, R. C., 6325, Topanga Canyon Boulevard, Woodland Hills, California 91364, U.S.A.
 Gugny, G., 20, Rue de Mogador, Paris 9e, France.
 Hackie, T. J., 1636, Pendosy Street, Kelowna, British Columbia, Canada.
 Heath, J. R., 18, Collins Street, Melbourne, C.1., Victoria, Australia.
 Hotz, Prof. R., Zahnärztliches Institut, Plattenstrasse 11, Postfach 163, 8028, Zurich, Switzerland.
 James, G. A., Orthodontic Department, University of Toronto Dental Faculty, 124, Edward Street, Toronto, Canada.
 Jann, H. W., 27, Briarwood Drive, Rochester, New York 14617, U.S.A.
 Krogstad, Olav, Jun., Kjeveortopedisk Avd., Norges Tannlegehogskole, Oslo, Norway.
 Lang, E. T., Broome's Building, Devon Street, New Plymouth, New Zealand.
 Lee Chee Onn, J., Institute of Health, Outram Road, Singapore 3, Malaysia.
 Lee Chin Kung, Government Dental Clinic, Grove Road, Penang, Malaysia.

- Leong, C. T., Government Dental Clinic, Pudu Road, Kuala Lumpur, Malaysia.
- Lervy, Major W. K., (R.A.D.C.) British Military Hospital Rinteln, British Forces Post Office, 29 (B.A.O.R., Germany).
- Ljungdahl, L., Ytterwägen 7, Kristianstad, Sweden.
- Lundström, Prof. A., Stureplan 19, Stockholm, Sweden.
- Lyn, M. R., 16, Tangerine Place, Halfway Tree, Kingston 10, Jamaica, W.1.
- MacAlpine, Miss M. T. N., P.O. Box 122, Liguanea P.O., Kingston 6, Jamaica.
- McDonald, J. H., Orthodontic Department, Dental Hospital of Melbourne, Elizabeth Street, Melbourne, Victoria, Australia.
- Magni, F., via Cesarea, 5/12a, Genoa, Italy.
- Mak, K. L., 16, Wilson Road, 1st Floor, Jardine's Lookout, Hong Kong.
- Manara, G., 23 Point Street, Sliema, Malta.
- Menezes, D. M., British Embassy, Rangoon, c/o Outward Mails Room, Diplomatic Service Administration Office, King Charles Street, S.W.1.
- Mortenson, S. Å., Folkstandvården, Kristianstad, Sweden.
- Moss, G. W., 1209, Wilcox Drive, Kingsport, Tennessee, U.S.A.
- Mulligan, W. O., 115, Hazen Street, Saint John, New Brunswick, Canada.
- Mun Fong Tam, c/o Kwong Hup Cheong, 31, Hugh Low Street, Ipoh, Malaysia.
- Norton, R. Y., St. James Buildings, 109, Elizabeth Street, Sydney, New South Wales, Australia.
- Oliver, H. T., 1414, Drummond Street, Montreal 25, Quebec, Canada.
- O'Meyer, R. X., 267, Rue St. Honore, Paris, 1er, France.
- Oosthuizen, L., 631, Robert Koch Medical Building, Pretorius Street, Pretoria, South Africa.
- Ovington, Major H. M. J. Y., H.Q. Northern Rhodesia Defence Force, P.O. Box 1931, Lusaka, Zambia.
- Patel, V. B., 39, Chowringhee Road, Calcutta, 16, India.
- Pihl, Miss E. M. K., St. Clemensgatan 32, Hälsingborg, Sweden.
- Pinsker, Dr. L. J., Lakewood Dental Center, 5464, South Street, Lakewood, California, U.S.A.
- Porterfield, Lt.-Col. M. F., Reading, J. F., 10th Floor, Park House, 187, Macquarie Street, Sydney, Australia.
- Robson, F. F., Robinson House, Union Avenue, Salisbury, Rhodesia, Africa.
- Sachs, N. J., 84-75, 168th Street, Jamaica, 11432, New York, U.S.A.
- Schleimer, Dr. Max, Lakewood Dental Center, 5464, South Street, Lakewood, California, U.S.A.
- Schouker-Jolly, M., 170, Rue Ordiner, Paris, 18, France.
- Selmer-Olsen, Prof. R., Ovre Ullern, Terr 2, Oslo 3, Norway.
- Sillman, J. H., 667, Madison Avenue, New York, U.S.A.
- Spring, D. F., Gilbert Court, 100, Collins Street, Melbourne, C.I., Victoria, Australia.
- Sundararay, Mrs. S., 40, Jalan Sekerat, Sungei Palani, Kedah, Malaysia.
- Tam, M. F., c/o 49, Kensington Hall Gardens, Beaumont Avenue, London, W.14.
- Taylor, A. Thornton, 175, Macquarie Street, Sydney, New South Wales, Australia.
- Tegner, G., Drottninggatan 62, Hälsingborg, Sweden.
- Tsaltas, G. K., 15, Arachous Street, Athens, Greece.
- Valentine, H. B., 9, Ward Street, Lower Hutt, New Zealand.
- Volmer Lind, H. C., Ortodonipolikliniken, Halmstad, Sweden.
- Watson, D. C., 76, Alexander Street, Wembley, Perth, Western Australia.
- Wenck, R. D., C.M.L. Buildings, 158, Margaret Street, Toowoomba, Queensland, Australia.
- Willis, L. E., Lister Building, Auckland, C.I., New Zealand.
- Yip, A. S. G., 771 Borebank Street, River Heights, Winnipeg 9, Canada.

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Vaus, K.

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Hunter, F. W.
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St. Albans
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Huntingdon
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Hewitt, A. B.

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Glass, D. F.

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Birchington
Rose, R. J.
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Kardman, Mrs. F. A.
West, V. C.
Canterbury
Bradley, P. E.
Chislehurst
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Dover
Rumble, J. D.
Gillingham
Ellis, D. S.
Maidstone
Evans, Miss L. G.
Orpington
Ellisdon, P. S.
Sandwich
Irwin, L. M.
Sevenoaks
Christian G. C.
Lawton, D. B.
Rubie, G. J.
Rumble, J. F. S.
Rushton, Prof. M. A.
Sheerness
Thorn, N. K.
Sidcup
Wreakes, G.
Tenterden
Crease, J. A.
Tunbridge Wells
Isaacson, K.
McAlpine, A. M.
Page, J.
Pilbeam, J. F.
Scoones, J. M.
Taylor, B. P.
White, Miss B. E. E.

Lancashire
Barroldswich
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Bolton
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Ratcliffe, C.
Liverpool
Atherton, J. D.
Birkinhead, B.
Clifford, E. J. S.
Lovius, B. B. J.
Murray, Miss J. P.
Wilson, A. J.
Wynne, T. H. M.
Manchester
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Booth, Mrs. J. H.
Cruikshank, A. J.
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Hartley, D. T.
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Lincoln
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Scunthorpe
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Hayes
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Isleworth
Hardy, D. K.
Kenton
Baker, C. D.
Northwood
Hudson, J. A.
Pinner
Eady, B.
Fulstow, E. D.
Ruislip
Rogers, D. A.
St. Margaret's-on-Thames
Lindon, Mrs. E. G.
Staines
Carr, A. S.
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Norwich
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Sheringham
Dumbrell, Miss J. M.
- Northamptonshire*
Northampton
Eagland, M. C.
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Phillips, J. E.
Wilson, C. P.
England, M. C.
Whiston
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- Northumberland*
Newcastle upon Tyne
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Littlefield, W. H.
Stubley, R.
Stockfield upon Tyne
Bennett, D. T.
- Nottinghamshire*
Nottingham
Attenborough, J. L.
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- Oxfordshire*
Banbury
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Oxford
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Taunton
Poulter, N. M.
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Wombourne (Wolverhampton)
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McDonald, A. A. M.
Mason, Mrs. E. M. B.
Roberts, G. H.
Bucklyvie
White, Prof. T. C.
Dunblane
Hood, M. R.
Dumfries
Baker, A.
Dundee
Archibald, W. C.
Martin, J. H.

McCartney, T. P. G.
McEwen, J. D.
Munro, D.
Edinburgh
Barrie, W. J. McK.
Buchan, A.
Gibson, A. C. L.
Hargreaves, J. A.
Haynes, S.
Hopkin, G. B.
Logan, W. Russell
Miller, Miss M. N.
Woods, A. R. H.

Elderslie (Johnstone)
Hughes, F. J.
Glasgow
Anderson, H. A.
Campbell, J.
Clark, W. J.
Cockburn, A.
Delaney, C. J.
Houston, J. G.
James, G. A.
MacCallum, W. A.
Thomson, Mrs. C. M.
Webster, Miss E. M.

Grangemouth
Stevenson, Wm.
Inverness
Ridley, Miss D. R.
Kirkcaldy
Mears, Miss R.
Paisley
McKechnie, R.
Portree
MacLeod, D. N.
Stirling
McGonigal, F.

V. Ireland

Ballymena
Brenchley, M. L.
Bangor
Dallas, H. A.
Belfast
Adams, C. P.
Bonnar, Miss E. M.

Hobson, G. S.
Richardson, A.
Richardson, Mrs. M. E.
Taylor, Miss B.
Cork
Hegarty, Professor M.
O'Connor, P. J.

Dublin
Clinch, L. M.
Dockrell, R. B.
Finn, S. D.
Fitzgerald, G. M.
Friel, S.

Greene, E.
Keith, J. E.
Kennedy, G. F.
MacCauley, F. J. L.
Thurles
Connolly-Meagher, T. A.

VI. Overseas Members

Australia
Adamson, K. T.
Bowden, B. D.
Cox, N. J.
Crisp, B. C.
Freer, T. J.
Gerraty, B. J.
Heath, J. R.
McDonald, J. H.
Norton, R. Y.
Reading, J. F.
Spring, D. F.
Taylor, A. Thornton
Watson, D. C.
Wenck, R. D.

Burma
Menezes, D. M.

Canada
Copeland, G. P.
Croll, R. O.
Eastwood, A. W.
Franklin, G.
Fransblow, P.
Hackie, T. J.
James, G. A.
Mulligan, W. O.
Oliver, H. T.
Yip, A. S. G.

Canary Islands
Gonzalez, R.

Egypt
Chohayeb, Mrs. Aida
France
Démogé, P. H.
Gugny, G.
O'Meyer, R. X.
Schouker-Jolly, M.
Germany
Lervy, W. K.
Greece
Bakatselos, S.
Tsaltas, G. K.
Hong Kong
Mak, K. L.

India
Ghosh, A. S.
Patel, V. B.

Italy
Magni, F.

Jamaica
Lyn, M. R.
MacAlpine, Miss M. T. N.

Malaysia
Chan, B. K.
Cheah, C. K.
Choo, T. C.
Lee Chee Onn, J.
Lee Chin Kung
Leong, C. T.

Mun Fong Tam
Porterfield, M. F.
Sundararay, Mrs. S.

Malta
Demajo, A.
Manara, G.

New Zealand
Ashby, J. W.
Bell, W. P. L.
Cook, C. C.
Gilbert, G. H.
Lang, E. T.
Valentine, H. B.
Willis, L. E.

Norway
Aamodt, A. C.
Engh, Olav, Jun.
Krogstad, Olav
Selmer-Olsen, R.

Rhodesia
Robson, F. F.

S. Africa
Braude, B.
De Villiers, J. F.
Faisinger, B. E.
Oosthuizen, L.

S. America
Abensur, J. (Peru)
Brears, O. B. (Ecuador)

Sweden
Ahlgren, J.
Billberg, B.
Granerus, R.
Granse, K. A.
Ljungdahl, L.
Lundström, A.
Mortenson, S. Å.
Pihl, Miss E. M. K.
Tegner, G.
Volmer Lind, H. C.
Werner, S. H.

Switzerland
Hotz, R.

U.S.A.
Bell, L. A.
Blausten, S.
Coval, N. M.
Goldstein, M. C.
Gosman, S. D.
Gottlieb, A. W.
Grossman, R. C.
Jann, H. W.
Moss, G. W.
Pinsker, L. J.
Sachs, N. J.
Schleimer, M.
Sillman, J. H.

Zambia
Ovington, H. M. J. Y.

ORTHODONTICS AS A PUBLIC SERVICE : THE WESSEX SURVEY

J. D. HOOPER, L.D.S., D.Orth. R.C.S.

Consultant Orthodontist, Wessex Regional Hospital Board

THE growth of orthodontics is perhaps one of the most spectacular developments which has come about since the inception of the National Health Service in 1948.

I believe that in the first year of the Health Service, less than 100 estimates were submitted to the Dental Estimates Board at Eastbourne. In 1965, 104,750 cases were completed. Similarly, on the hospital side, there were no Orthodontic Consultants other than those associated with teaching hospitals. Now there are twenty-six in England and Wales, and forty more appointments have now been approved by the Ministry of Health following the recent review of dental staffing in the Hospital Service.

As I have been closely associated with this very rapid development, I thought it might be of interest to members of this Society to provide some facts about what has happened in that part of the Wessex Regional Hospital Board, to which I was appointed in 1950. I also hope that these facts may be of help to some of the forty new consultants who will be planning their new departments at some time or other during the next decade.

It is sixteen years since the orthodontic department opened in Bournemouth, which means I am about half way to retirement, and as I also celebrated my half century this year, this seems a most appropriate moment in time to look back into the past, and—ever-hopeful—forward into the future. I said that I would give you some facts, and my ability to do this is due, very largely, to the foresight of my good friend Gordon Dickson, of the Royal Portsmouth Hospital. Realizing what a wealth of clinical material was going through our hands, he suggested that we devise some system of recording so that at some future date statistics of various kinds could be obtained. Eventually, after a long period of gestation, the Wessex Orthodontic Survey was born and is still in use. It is from this survey that the facts and figures I am going to produce were derived.

After the Survey had been running for nearly three years, well over 1000 cases which had

completed treatment in one or other of my two clinics, had been recorded, and I felt that this was a large enough figure to provide an interesting analysis, and is the basis of the factual and statistical part of this paper.

Although all the consultants in the Wessex Regional Hospital Board are submitting their treated cases to the Survey, I decided to use only those cases which had been treated in my clinic, either by myself or by my registrars or clinical assistants. The figures could then be related to the methods of treatment in use there, and also to the approach to treatment which I favour and which I fully realize, is an individual approach, not necessarily shared by others.

Before showing you the figures, therefore, I think it is right to set before you my views on and attitude to orthodontic treatment since the figures are bound to be considerably affected thereby.

Orthodontic treatment is different from most other forms of treatment, since those requiring treatment are not ill, or in pain, and, indeed, are often unaware of the nature and severity of their condition. Furthermore, most of them are children not yet able to decide their requirements for themselves. The decision to treat depends on the degree to which the individual differs from the norm, but the norm is arbitrary, and the degree of variation from it which the individual will accept is itself very variable, and this puts a considerable responsibility on the operator to use his judgment.

Thus, the criteria of orthodontics have tended to vary considerably, and to be affected by the system under which treatment was available. In private practice there is a tendency for treatment to become ever more elaborate. This is in accord with the principles of economics in an affluent society as described by Galbraith (1958). There is no incentive for the operator to shorten or simplify his treatments, and the process ends with the type of orthodontic treatment practised in North America, where very complicated and expensive treatment is available for only a tiny minority of the population.

Apart from the social aspects, it is to my mind, very doubtful if even those who can afford such treatment really want it, or whether the benefits they get from it are really worth the time and

nature of orthodontics. The scientific approach tends to produce a somewhat Euclidean attitude to orthodontics where the teeth are regarded as part of an intricate pattern and treatment is an

WESSEX REGIONAL HOSPITAL BOARD

ORTHODONTIC ANALYSIS

(Part I—DIAGNOSIS)

Name :	Hospital Reference Number : 19-24	Sex : 25	Operator 26
		Male 1	2
		Female 2	3
			4
Age at First Examination 27-30		Dental Arch Relation	40
Years Months		Angle Class 1	1
		" " II div. 1	2
		" " II div. 2	3
		" " II unclass.	4
		" " III	5
Age at Commencement of Treatment 31-34		Habits	41
Years Months		Thumbsucker	1
		Fingersucker	2
Skeletal Pattern		Congenital Deformities	42
Sk. 1	1	Hare-lip	1
Sk. 2	2	Hare-lip and cleft palate	2
Sk. 3	3	Bilateral Hare-lip and cleft palate	3
		Other	4
Frankfurt-mandibular Plane angle			43
High	1	Supernumerary Teeth	1
Normal	2	Missing Teeth	2
Low	3	Palatal Canines	3
		Other misplaced teeth	4
Resting Lip Posture		Submerged Deciduous Teeth	44
Lips competent	1	No. of :—	
Lips incompetent	2		
Swallowing			45
Normal	1		
Abnormal	2		
Speech "S-sound"			46
Normal	1		
Interdental	2		

Fig. 1.—Analysis card—front (diagnosis).

money expended. However, presumably they approve of the system which produces it, at any rate for the time being.
There is also a tendency for orthodontic treatments to become over-elaborate in the research and teaching departments of University Dental Faculties. This, however, is for a very different reason and is inherent in the very

exercise in the various possible combinations in which they can be arranged or re-arranged.
It is, of course, most important that such activities should go on and, indeed, we should have no progress without them, but I do not feel that this approach is likely to satisfy the individual requirements of the average patient.

It is my belief that it is in some form of public service that the type of orthodontic treatment which most nearly accords with the requirements of ordinary people will eventually be evolved

specialists will presumably be trained in the Hospital Service.

It is my dream that one day the promised health centres will be provided in which health

OBJECTIVE		(Part II—TREATMENT)	
Alignment of : 47		Improving Relationship : 48	
Upper L.S.	1	Labial Segments	1
Lower L.S.	2	Buccal Segments	2
Upper/Lower L.S.	3	Labial/Buccal Segments	3
Other	4	Other	4
Treated by Extraction			
49 <div>Upper left 8 7 6 5 4 3 2 1</div>		<div>Extraction</div> <div>Upper right 1 2 3 4 5 6 7 8</div> 50	
51 <div>Lower left 8 7 6 5 4 3 2 1</div>		<div>Lower right 1 2 3 4 5 6 7 8</div> 52	
Not treated 53		Number of Visits 62-63	
Not justified 1		Duration of Pre or Mid Treatment observations 64-65	
Impossible 2		<div>Months</div>	
Type of Appliance 54		Treatment 66-67	
Labiolingual 1		<div>Months</div>	
Multiband 2		Retention 68-69	
Labiolingual and Multiband 3		<div>Months</div>	
55		Post Treatment Observation 70-71	
Andresen 1		<div>Months</div>	
Oral Screen 2		Surgery Time 72-75	
Space Retainers 3		<div>Hours Mins.</div>	
Other 4		<div></div>	
56		Patient Co-operation 76	
Anchorage 57		Adequate 1	
Intermaxillary 1		Inadequate 2	
Extra-oral 2		Failed to complete 3	
Both 3		77	
Total Number of Appliances		<div></div>	
Fixed 58		78	
Removable 59		<div></div>	
Breakages 60		<div></div>	
Result 61			
No Improvement 1			
Some improvement but objectives not completely attained 2			
Objectives completely attained 3			
Relapsed 4			

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Fig. 2.—Analysis card—back (treatment).

and provided. Such treatment would not be of a low standard, but would be simple rather than elaborate, pay equal attention to both function and aesthetics, and, above all, would be accomplished by methods making the smallest demands on the patient's time and ability to co-operate. I am not assuming that this service will necessarily be provided in hospitals, although the necessary

will be actively promoted and disease prevented. Orthodontics seems to me to fit perfectly into such a concept since the production of a healthy dentition is obviously its main objective.

I would like to define treatment as 'the relief of a condition which is actually causing suffering or is likely to do so in the future'. Thus an irregular tooth does not require treatment unless,

in the operator's judgment, it is either causing the patient physical or mental suffering now or, because of its position, is likely to later on.

One should not treat orthodontic conditions 'because they exist', and a Class II, division 1 condition in which the appearance is satisfactory and the mouth healthy should not be regarded as Mount Everest, whose apex must be conquered by the operator's skill and enthusiasm.

I agree broadly with the typically forthright statements made by John Hovell (1962) in his paper to the thirty-eighth Congress of the European Orthodontic Society in which he said; 'the order of preference in orthodontic treatment is undoubtedly as follows:—

'*First:* No treatment at all and the acceptance of minor irregularities.

'*Second:* Extractions with no active orthodontic treatment.

'*Third:* Minimal simple appliance therapy with or without extractions.

'*Last:* Complicated appliance therapy.'

I also remember hearing a story about the late, much respected, Harold Chapman, which may not be strictly true, but is very much in accordance with the spirit of that human personality. It was said that he would never complete a treatment plan until he had been told the cost of the 'bus fare from the patient's home to the London Hospital and if it was over sixpence he was very loath to prescribe any treatment at all!

Obviously one does not want to press this argument too far, but I do believe that the patient's circumstances must be taken into account when planning treatment and a plan devised which is right for that particular patient. Good treatment in my opinion is always a compromise. The opposite of compromise is dogma and as all history shows dogma does not relieve suffering, it causes it.

Treatment should have a definite objective which should be expressed in terms of tooth movement, not in terms of the appliance to be used to achieve it. This objective need not necessarily be the attainment of some abstract concept such as 'normal occlusion', but should be related more directly to the patient's needs. Normal occlusion exerts a fascination for orthodontists similar to that of 'par' or 'bogey' for golfers. It is an ideal more striven for than achieved. Nevertheless, there is much good and useful work to do which is not directed towards the achievement of this ideal state. I am personally gradually coming to the belief that alinement is more important than occlusion. Certainly in many cases the achievement of good alinement of the individual dental arches may be more productive of lasting benefit than the attempt to produce 'normal occlusion'.

Treatment must also be effective. To my mind the reputation of our speciality is not improved by long and tedious procedures which produce

either no improvement at all or only transitory benefit. One must remember that taking into account the patient's journeys, the time consumed by orthodontic treatment can be very high and the disruption of family and school life very considerable. The benefits, therefore, should be in proportion to the efforts and sacrifices which many families make in order that their children may receive treatment.

Finally, I do not accept the idea that the country cannot afford to provide the best treatment for everyone. Elaborate techniques if they are necessary and desirable can, and must, be simplified so as to increase their availability.

Indeed, the ever-increasing availability of orthodontics is to me one of the most gratifying things and we should be proud that in this as in so many other aspects of social progress our country leads the world. There is certainly no room for complacency, but I see no harm in expressing a little quiet satisfaction with what we have achieved in this period of our history in spite of the forebodings of the prophets of gloom both at home and abroad.

The foregoing is an attempt to define my approach to orthodontic treatment and the figures which follow must be related to that approach and not in any way regarded as setting standards or norms for other people. Orthodontics is a young subject and there is ample scope for variation.

The Wessex Orthodontic Survey was started early in 1963 when the analysis card was finally agreed by the four orthodontic consultants of the Region.

The card was produced in collaboration with the Machine Accounting Unit at Winchester, who would carry out any subsequent analysis. The Hollerith system is used which is based on the punched-card principle, and permits the use of 80 columns with up to 10 positions in each column.

It was decided to record both clinical conditions and treatment characteristics and these were printed on opposite sides of the card (*Figs. 1, 2*).

The card is filled up at the end of treatment. When a patient is finally discharged the necessary facts are transferred from the record card to the analysis card. These cards are then sent to the Machine Accounting Unit where the facts are transferred to punched cards and stored.

The present analysis is based on 1329 such cards representing 1329 unselected consecutive cases whose treatment had been completed during the years 1963, 1964, and 1965 at either of the two clinics in our area.

It is emphasized that a 'completed' case means one for whom all treatment, not merely a course of treatment, is completed. No patient appears in the survey more than once. Thus a patient who may, at various times, have had

separate courses of treatment for different conditions occurring at different times would constitute only one case, and all the orthodontic treatment or periods of observation would be counted.

In this respect the figures may well differ from those produced for example by the Ministry of Health or by Local authorities where a 'case' may mean a course of treatment which, though complete in itself, may be followed by other courses.

Table I.—TIMES ALLOTTED FOR ORTHODONTIC PROCEDURES AND USED TO ESTIMATE SURGERY TIME

	<i>Minutes</i>
First impressions	15
Diagnosis	10
Impressions for appliances	5
Fit removable appliance	5
Adjust removable appliance	5
Make bands—per band	5
Fit fixed appliances (per band)	5
Adjust fixed appliances	5
Change arch—remake fixed appliance	20
Observation visit	5
Review	10

Except for the dental arch relationship this analysis is not concerned with the diagnostic side of the card (*Fig. 1*).

The treatment side (*Fig. 2*) is mainly factual and self-explanatory except for column 61 and columns 72–75 which require some comment.

Column 61 represented an effort to classify the results of treatment. However, I decided not to include these in the analysis as the assessment

the appointments clerk for each operation (*Table I*).

Although this cannot be regarded as exact for each patient it is thought that the errors must cancel out since the appointment system works well and the clinics are rarely more than half an hour behind time. If this was taken into account it would add approximately one minute per visit to the average treatment times shown in the analysis.

*Table III.—RESULTS OF WHOLE SAMPLE
Treatment Characteristics*

Average number of visits	16.5 months
Average duration of pre- and/or mid-treatment observation	17.5 months
Average duration of treatment	12.4 months
Average duration of retention	10.1 months
Average duration of post-treatment observation	13.5 months
Average duration of surgery time	1.7 hours

Table II shows certain characteristics of the patients included in the survey.

The ratio of boys to girls was rather closer than might have been expected. It is often stated that parents are more anxious to seek treatment for girls than for boys. This is so, but the difference is slightly less than 10 per cent.

The average age at referral and at commencement of treatment are much as would be expected.

The arch relationship was classified according to the anteroposterior relationship of the cheek teeth after allowing for individual tooth movements.

*Table II.—RESULTS OF WHOLE SAMPLE
Case Characteristics*

<i>Sex:</i>	Boys	604 (45.6 per cent)
	Girls	725 (54.4 per cent)
	<i>Total</i>	1329 (100.0 per cent)
<i>Average age at first examination:</i>	10½ years	
<i>Average age at commencement of treatment:</i>	11 years	
<i>Arch relationship:</i>	Class I	650 (49.9 per cent)
	Class II, division 1	366 (27.5 per cent)
	Class II, division 2	75 (5.5 per cent)
	Class II unclassified	93 (7.0 per cent)
	Class III	135 (10.1 per cent)

was bound to be subjective. I have no reason to believe that the results of treatment in these cases differ very greatly from those of other operators. One has one's successes and one's failures, one's triumphs and one's disappointments, and the ratio of the one to the other seems to be such as to ensure a very adequate supply of work.

Columns 72–75 indicate the surgery time expended on each patient and this was not measured by a stop watch but was estimated on the basis of the amount of time allotted by

Table III shows certain treatment characteristics of the whole group. The figures for pre- or mid-treatment observation seem high, but may include periods of observation which occur between separate courses of treatment.

The amount of surgery time may seem low, but as will be seen later the sample included a number of cases who had no active treatment with appliances.

The sample was then broken down into the following 6 main groups which were then subjected to further analysis.

The groups were as follows:—

1. Cases receiving no treatment at all	106
2. Cases receiving observation only	37
3. Cases receiving extractions only	26
4. Cases receiving extractions and observation only	260
5. Cases receiving appliances and observation only	196
6. Cases receiving extractions, appliances, and observation	707

Table IV.—CASES RECEIVING NO TREATMENT AT ALL

	TREATMENT NOT JUSTIFIED	TREATMENT IMPOSSIBLE
Class I	55	5
Class II, Division 1	23	3
Class II, Division 2	5	—
Class II unclassified	3	—
Class III	7	5
Total	93	13
	106	

Table IV shows those cases which received no treatment at all. It will be seen that there were 106 such cases representing 7.9 per cent of the whole sample.

The great majority were those in which it was considered that the condition was of too minor a character to justify treatment.

Table V shows those cases which were kept under observation before deciding not to carry out treatment.

There are only 37 such cases, but these added to those in *Table II* indicate that 10 per cent of cases in the sample received no actual orthodontic intervention. It is, I feel, just as important a part of our duties to decide when to withhold treatment as it is to decide when to prescribe it.

The very long average period of observation in the four Class III cases was due to the very early age at which this type of patient is so often referred.

Table VI shows a relatively small number of cases treated by extraction only. Most are in Class I, and teeth most frequently extracted were first premolars followed by first molars.

Table VII shows the considerable number of cases treated with extractions preceded or followed by periods of observation, but with no appliances. These cases added to those in the preceding groups indicate that 32 per cent of the total sample were not treated with appliances.

The great majority of such cases as might be expected were in Class I where good alinement had developed naturally following extractions to relieve crowding.

The numbers in the other groups are too small to justify further comment.

Table VIII shows the same cases as in *Table VII*, classified to show the teeth most frequently extracted. In by far the greatest number of cases the teeth extracted were the first premolars.

Table IX shows those cases receiving appliances and observation only. There were only 197 such cases out of a total of 904 who received some form of active treatment, so that cases

Table V.—CASES RECEIVING OBSERVATION ONLY

	Number of Cases	AVERAGES	
		Observation in Months	Surgery Time in Minutes
Class I	23	21	35
Class II, division 1	7	28	56
Class II, division 2	2	8	33
Class II unclassified	1	6	35
Class III	4	47	54
All the cases	37	22	42

The arch relationship proportions follow closely the proportions of the total sample and do not seem to have been a factor on the decision to withhold treatment.

treated without extractions were very much in the minority.

The greatest number of both fixed and removable appliances was required by Class II, division

2 cases, and this condition was also responsible for the greatest number of visits and the longest periods of treatment and surgery time.

Retention time is highest in Class II, division 1 and post-treatment observation was most prolonged in Class III cases.

Table X shows the same cases as in Table IX, analysed according to the method of treatment. Cases treated with fixed appliances show an

increase in the number of visits and in treatment duration, but a much greater increase, almost double, in surgery time.

Table XI is an analysis of the greatest number of cases, 707 in all, whose treatment included extractions, appliances and observation.

The following points may be noted:—

1. The proportion of Class II, division 1 cases is much higher in this group than in the total

Table VI.—CASES RECEIVING EXTRACTION ONLY, CLASSIFIED TO SHOW TEETH MOST FREQUENTLY EXTRACTED

	RIGHT								LEFT							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
Class I	—	—	6	3	9	1	1	—	—	—	—	6	—	4	—	—
Class II, division 1	—	—	3	—	6	1	—	—	—	—	1	6	—	2	—	—
Class II, division 2	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	—
Class II, unclassified	—	—	1	—	1	2	—	—	—	—	2	1	—	1	—	—
Class III	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Class I	—	—	5	—	9	—	1	—	—	—	—	7	—	3	—	—
Class II, division 1	—	—	3	—	3	1	—	—	—	—	1	3	—	2	—	—
Class II, division 2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Class II unclassified	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—
Class III	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—

Table VII.—CASES RECEIVING EXTRACTIONS AND OBSERVATION ONLY, CLASSIFIED ACCORDING TO DENTAL ARCH RELATIONSHIP

	AVERAGES				
	Number of Cases	Number of Visits	Pre- or mid-treatment Observation in Months	Post-treatment Observation in Months	Surgery Time in Minutes
Class I	187	6.0	9.1	14.4	55
Class II, division 1	24	4.2	7.0	4.8	41
Class II, division 2	6	5.3	7.8	17.8	39
Class II unclassified	29	6.0	9.0	8.3	38
Class III	14	6.4	24.9	12.4	49
All the cases	260	5.6	11.5	11.5	44

sample indicating that this type of case most frequently requires treatment with both extractions and appliances.

3. The number of visits does not show much variation, but is highest in Class III and Class II, division 1 probably as a result of early referral.

Table VIII.—CASES RECEIVING EXTRACTIONS AND OBSERVATION ONLY, CLASSIFIED TO SHOW THE TEETH MOST FREQUENTLY EXTRACTED

	RIGHT								LEFT								
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	
Class I	1	—	33	8	100	10	8	—	1	6	10	98	11	28	7	1	Upper
Class II, division 1	—	—	5	1	13	1	—	—	1	1	1	12	1	5	—	—	
Class II, division 2	—	—	—	—	6	—	—	—	—	—	—	6	—	—	—	—	
Class II, unclassified	—	—	1	—	21	4	—	—	—	—	5	19	—	2	—	—	
Class III	—	—	2	1	5	1	1	—	—	—	—	7	1	—	—	—	
Class I	1	—	35	4	96	—	8	1	2	6	—	94	7	32	—	1	Lower
Class II, division 1	—	—	5	1	8	2	—	—	—	—	2	8	1	5	—	—	
Class II, division 2	—	—	—	—	4	—	—	—	—	1	—	4	—	—	—	—	
Class II, unclassified	—	—	3	—	9	—	2	—	1	4	—	6	2	3	—	—	
Class III	—	—	3	—	7	1	—	—	—	—	1	8	1	2	—	—	

Table IX.—CASES RECEIVING APPLIANCES AND OBSERVATION ONLY, CLASSIFIED ACCORDING TO DENTAL ARCH RELATIONSHIP

	AVERAGES								
	Number of Cases	Number of Fixed Appliances	Number of Removable Appliances	Number of Visits	Pre- or mid-treatment Observation in Months	Treatment in Months	Retention in Months	Post-treatment Observation in Months	Surgery time in Hours and Minutes
Class I	99	0.5	1.3	17.3	4.9	8.8	7.0	7.6	1.54
Class II, division 1	49	0.7	1.5	22.1	5.6	13.8	14.0	10.5	2.17
Class II, division 2	14	1.1	1.6	22.2	4.1	18.4	11.3	5.6	2.35
Class II, unclassified	5	0.4	1.4	15.0	—	8.2	5.4	7.0	1.3
Class III	30	0.6	1.5	19.3	9.6	7.8	8.7	15.6	2.1
All the cases	197	0.6	1.4	19.1	6.0	10.8	9.2	9.2	2.1

2. The proportion of fixed to removable appliances is highest in Class III, next highest in Class II, division 2 and lowest is Class I. The greatest total number of appliances is used in Class II, division 1.

4. The length of treatment is also very even throughout the group but is highest in Class II, division 1.

5. Retention and post-treatment observation are highest in Class III.

6. The surgery time is highest in Class III cases and lowest in Class I.

Table XII shows the same cases as in Table XI analysed according to the method of treatment. This table shows chiefly the considerable increase

The pattern of treatment is shown to be in line with the great mass of treatment carried out latterly in this country being based mainly on the extraction of first premolars with the next most frequently extracted teeth being the first

Table X.—CASES RECEIVING APPLIANCES AND OBSERVATION ONLY, CLASSIFIED ACCORDING TO APPLIANCES USED

	AVERAGES								
	Number of Cases	Number of Fixed Appliances	Number of Removable Appliances	Number of Visits	Pre- or mid-treatment Observation in Months	Treatment in Months	Retention in Months	Post-treatment Observation in Months	Surgery time in Hours and Minutes
Fixed appliances	16	1.6	—	20.7	2.1	9.8	10.0	11.9	2.28
Removable Appliances	119	—	1.5	15.8	4.8	9.3	7.7	9.6	1.32
Fixed and Removable Appliances	58	1.6	1.7	25.6	5.4	12.5	11.1	8.2	2.59

Table XI.—CASES RECEIVING EXTRACTATIONS, APPLIANCES, AND OBSERVATION, CLASSIFIED ACCORDING TO DENTAL ARCH RELATIONSHIP

	AVERAGES								
	Number of Cases	Number of Fixed Appliances	Number of Removable Appliances	Number of Visits	Pre- or mid-treatment Observation in Months	Treatment in Months	Retention in Months	Post-treatment Observation in Months	Surgery time in Hours and Minutes
Class I	270	0.3	1.6	19.9	12.1	10.9	6.5	8.9	2.1
Class II, Division 1	260	0.6	1.9	23.8	8.1	14.6	9.5	8.5	2.29
Class II, Division 2	46	0.7	1.7	21.1	11.2	11.2	7.6	8.4	2.13
Class II, unclassified	55	0.4	1.7	20.7	8.1	13.4	5.9	9.1	2.15
Class III	76	1.2	1.6	24.1	11.3	11.0	10.0	15.6	2.38
All the cases	707	0.6	1.7	21.9	10.1	12.3	7.9	10.1	2.19

Table XII.—CASES RECEIVING EXTRACTATIONS, APPLIANCES, AND OBSERVATION, CLASSIFIED ACCORDING TO METHOD OF TREATMENT

	AVERAGES								
	Number of Cases	Number of Fixed Appliances	Number of Removable Appliances	Number of Visits	Pre- or mid-treatment Observation in Months	Treatment in Months	Retention in Months	Post-treatment Observation in Months	Surgery time in Hours and Minutes
Fixed Appliances	30	1.8	—	23.6	16.8	9.4	5.7	15.4	2.55
Removable Appliances	4.75	—	1.8	19.2	9.9	11.4	6.8	9.9	1.55
Fixed and removable appliances	194	1.8	1.8	28.5	9.9	15.0	11.1	8.6	3.21

in treatment time and surgery time in the cases where fixed appliances were employed.

Table XIII shows the same cases as in Tables XI and XII classified to show the teeth most frequently extracted.

molars. Extractions as a whole are more numerous in the upper jaw than in the lower as would have been expected.

Extraction of the first molars, however, occurs almost equally frequently in both jaws due

probably to the frequently poor quality of the teeth necessitating their loss rather than purely orthodontic considerations.

The table indicates also that any tooth can and has been extracted in certain circumstances. It is my belief that it is occasionally justifiable

to bring orthodontic treatment of a high standard within the reach of every child who needs it in the areas to which they have been appointed.

In conclusion, I wish to record my grateful thanks to Mr. Bales and the staff of the Machine

Table XIII.—CASES RECEIVING EXTRACTIONS, APPLIANCES, AND OBSERVATION, CLASSIFIED TO SHOW THE TEETH MOST FREQUENTLY EXTRACTED

	RIGHT								LEFT							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
Class I	—	—	48	10	171	6	9	3	—	4	5	175	17	43	—	—
Class II, division 1	—	2	28	7	203	1	1	2	3	1	2	208	4	26	3	—
Class II, division 2	—	1	11	5	26	—	—	—	—	—	—	29	5	8	1	—
Class II, unclassified	—	1	8	4	41	—	—	—	—	—	1	37	4	9	2	—
Class III	—	—	11	6	35	2	2	—	1	—	2	33	6	12	1	—
Class I	—	1	52	5	147	1	11	—	—	12	2	139	7	45	—	—
Class II, division 1	—	2	26	8	71	1	12	3	3	6	1	68	6	28	3	—
Class II, division 2	—	1	11	5	26	—	—	—	1	1	—	12	—	10	3	—
Class II, unclassified	—	2	7	2	15	1	4	—	—	—	1	15	3	7	2	—
Class III	—	1	15	3	46	3	—	—	1	—	3	42	3	13	2	—

Upper

Lower

to extract, for example, canines and incisors, where this greatly shortens the time necessary to achieve a satisfactory result.

This concludes the survey and I regret that its presentation has necessitated showing so many figures. Figures, however, are essential to surveys, and I do hope that this one will be of interest especially to our younger members who will be the future leaders of our speciality.

When they eventually assume positions of responsibility it is my hope that they will not be content with technical perfection, but will aim

Accounting Unit for analysing the cards and providing the tables, to Mrs. Seviour and Miss Tompson for typing the paper and the tables, and most especially to my patient and long suffering senior registrars, Miss M. C. McCall and Mr. A. M. Cookson, who laboriously filled in the survey cards.

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MIDLINE SPACES

J. H. GARDINER, B.D.S. (V.U. Manch.), D.Orth. R.C.S. (Eng.)

Head of the Orthodontic Department, Sheffield University School of Dental Surgery

INTRODUCTION

REFERENCE to midline spacing appears regularly in the dental literature from the beginning of this century, and its absence from previous literature suggests that in earlier times it was either not noticed or not considered to be an anomaly. Most would agree that the number of enquiries from general practice show a continuing interest in this small, but visible, characteristic, and this spurred me to collect the information available



in the hope of gathering yet more from this learned Society.

Over the years, the concept of midline spacing has gradually changed. Earlier it was considered to be an isolated condition, almost always associated with an over-large labial fraenum. Today, however, the upper midline space has come to be regarded as a part of a complex, as seen, for instance, in patients with prominent incisors and oral soft-tissue anomalies. Some do not regard it as an anomaly and jealously preserve it, as in the case of one well-known film actor, and even on the television screen diastemata are beginning to make their appearance. At least one parent has enquired anxiously if orthodontic treatment might remove what he considered to be a prized

family characteristic in his son! Possibly there are those very masculine faces where a narrow diastema set off by a colourful bow-tie gives a slightly dashing appearance, but, in others, (Fig. 1) a wide diastema can have a most unfortunate effect.

INCIDENCE

Just before the last war a Californian orthodontist (Taylor, 1939) made an informed factual



Fig. 1.—Disfiguring appearance produced by an over-wide upper midline space.

contribution to our knowledge when he conducted a personal examination of over 1500 schoolchildren in north Hollywood. These figures are often quoted, but it is not always stated that his was not a detailed examination

Table I.—J. E. TAYLOR'S SURVEY (1939)

AGE IN YEARS	NUMBER	PERCENTAGE
6	66 out of 68	97
6-7	29 out of 33	88
10-11	18 out of 37	49
12-18	75 out of 1067	7

in that no diastema widths were given, nor were any contributory factors examined, but the numbers of children with any type of midline space are given by him in Table I.

One has to take these figures with a slight reservation because in the 6-year and 6-7-year groups there was no differentiation between the so-called 'physiological spacing' of the upper central incisors on eruption and the unnatural spacing due to other causes. I am sure, too, that Taylor must have come across some children in the 6-7-year groups, where, due to the shedding of the deciduous central incisors or the non-eruption of the permanent central incisors, it may not have been possible to diagnose the presence of a median diastema.

Another survey of 1000 schoolchildren in Sheffield (Gardiner, 1956) between the ages of 5 and 15 years was recorded on punched cards (Copeland Chatterson system) so that correlation

Limnogale, is a slightly smaller otter-like animal from Madagascar having an upper labial fraenum which passes between the divergent central incisors to the incisive papilla. A more homely example of insectivore is the European hedgehog whose conical upper incisors are separated but convergent, and between them lies the end of the philtrum and the incisive papilla. Yet another example of the insectivore is the *Gymnura* with an arrangement of philtrum and incisive papilla rather like the hedgehog. This is a larger rat-like animal with a body length of up to 18 inches and also comes from S. E. Asia. Among the primates the *Galago* has a small incisive papilla in the diastema between the small conical incisors; known as the Bush Baby, it comes from

Table II.—AGE DISTRIBUTION OF MEDIAN DIASTEMA
(Total: 278 in 1000)

AGE	6 yr.	7 yr.	8 yr.	9 yr.	10 yr.	11 yr.	12 yr.	13 yr.	14 yr.	15 yr.
NOT ASSESSABLE	12	17	1	1	1	—	—	—	1	—
UP TO 0.5 MM.	4	5	7	5	1	2	4	2	6	1
0.6 TO 0.9 MM.	13	10	12	12	1	5	5	9	10	—
1.0 TO 1.9 MM.	14	35	28	16	5	4	8	3	2	1
2.0 TO 2.9 MM.	5	19	7	5	—	—	—	1	1	—
3 MM. AND OVER	4	3	1	—	—	—	1	—	1	—
TOTAL/YEAR TOTAL	40/87	72/147	55/128	38/115	7/70	11/98	18/98	15/128	20/101	2/28
PER CENT	46	48	43	33	10	11	18	12	20	7

of the various factors could be readily ascertained. The incidence of upper midline spaces was found to be on average 27 per cent, but obviously varied with the age, as seen in *Table II*. It would have been more satisfying numerically if the 12-year-olds and the 14-year-olds had been more considerate, but possibly their sample was rather small and possibly the replacement of the deciduous canines could have influenced these figures. Lower median diastemata did occur, but only to the extent of 0.3 per cent. Also, lower lingual fraena occurred to the extent of 1.9 per cent, but it is doubtful if they had much influence on lower median diastemata.

COMPARATIVE ANATOMY

Briefly, we might consider some of the species in the animal kingdom which consistently have a midline diastema, and for this information and these illustrations I am indebted to Mr. G. James (1966). Among the insectivora there are at least four examples. The tree shrew (*Fig. 2*) has a small incisive papilla lying between and labial to the two central incisors. This animal comes from South East Asia and has a head and body length of 6-9 inches. An amphibious insectivore, the

Africa and has a body length of up to 15 inches. Others with a median diastema in this group are the lemurs from the island of Madagascar, and include the famous Aye-Aye. Obviously there will be larger animals with this condition, but their lip and fraenal attachments do not appear to have been investigated as closely as these of Mr. James' investigation.

All of these species are subject to individual variation as are other animals, and I can recall at least one pedigree spaniel being brought along in the hope that something could be done for a trifling diastema which was apparently affecting his success in dog shows!

FOETAL DEVELOPMENT

The early development in the human foetus of the anterior part of the maxilla can be traced from about the third week when the foetus is about 3 mm. in length. The portion we are now considering appears to develop from the fronto-nasal process.

The anatomists have advanced many arguments on the relation between the maxilla and the so-called premaxilla, but one widely accepted view is that the maxillary processes go forward to

enclose the premaxilla, and it is said that the premaxilla in humans begins to fuse with the maxilla in the second month intra-uterine. In the palate of a three-month foetus the anterior palatine papilla appears large compared with the rest of the palate. The tuberculum of the upper lip also appears exaggerated at this stage, and in a four-month foetus it seems to be clearly differentiated from the rest of the upper lip (Orban, 1953). From this tuberculum a fold passes to the anterior palatine papilla forming

had confirmed that it was possible in rare cases of cleft palate for a median cleft to extend forward between the central incisors. In child skulls (Fig. 3A) there is a patent median suture between the maxillae of varying widths, and the date at which this suture closes (Fig. 3B) appears to vary greatly. Professor Miles (1966), in a survey of over a hundred Anglo-Saxon skulls, found, in general, that those belonging to the 18–21 age-group had patent intermaxillary sutures giving the appearance that, if necessary, the

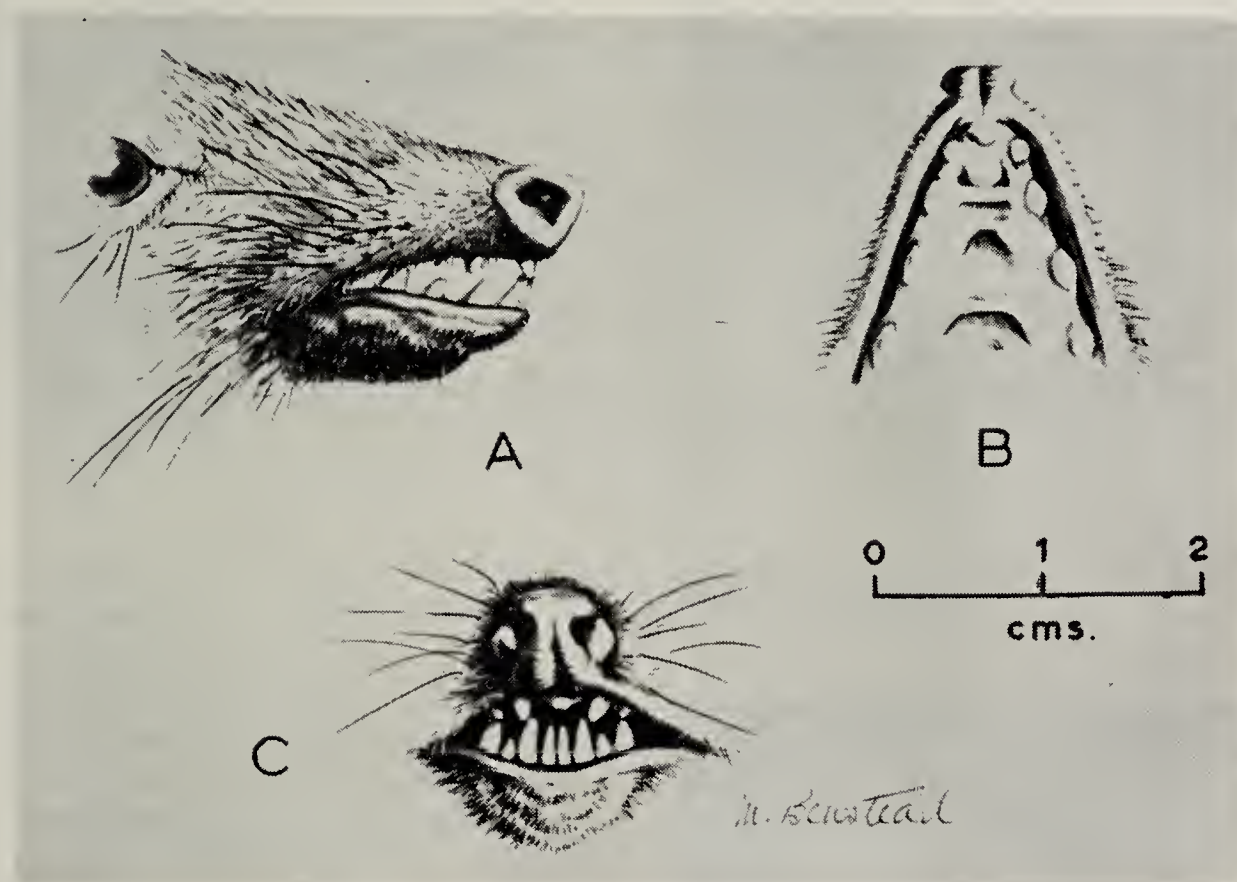


Fig. 2.—Upper dentition of the tree shrew.

the tecto-labial fraenum. The tuberculum on the upper lip can persist and can be seen sometimes in patients presenting with a very prominent fraenum. Anderson (1938) collected five foetal heads at 2, 4, 4½, 7, and 9 months respectively and sectioned them in the horizontal plane at the level of the incisive papilla; he found the fibres of the labial portion of the fraenum to be attached superficially and also to diverge to the left and to the right of the midline, and was of the opinion that the fibres of the fraenum do not extend between the two halves of the maxilla.

THE MIDLINE SUTURE

Considering further the question of the midline suture, its possible significance was recognized as far back as 1905, when Barnes, of Cleveland, U.S.A. (quoted by Ketcham, 1907) stated that, 'the operation on fraenum labium did not remove all tendency to separation, possibly due to cleft or non-union of the anterior part of the inter-maxillary bones'; shortly before this Albrecht (also quoted by Ketcham, 1907)

intermaxillary bones could be disarticulated. In the older age-group, i.e., 39–41 years, he found that the anterior part of the median intermaxillary suture appeared more closed and one seemed to be fused completely on the labial aspect. A recent radiographic survey of this area in Sheffield patients between 4 years and 73 years of age confirms that it is possible to have a partially patent median suture at 73 years and a closed suture in a patient of 8 years, but it was found that even in this wide age range only 12 per cent could be said to have radiographically the appearance of closed median sutures.

Latham (1966) in his study of maxillary sutures, found the *rate of growth* in the median palatal suture to decline rapidly along its whole length between birth and 18 months, and at 2 years of age had the appearance of being inactive. He is of the opinion that masticatory stresses may result in movement of the maxillae, and this could delay or prevent their sutures closing. Although the radiographic appearance of the median suture cannot be regarded as conclusive evidence of either a patent or a closed suture, nevertheless it does give a measure of comparison,

and, in the radiographic survey referred to previously, it was noticed that where any trauma or surgery occurred in the midline then the median sutures became at that part obliterated. In a patient of 20 years, for example, there appeared to be partial fusion of the midline suture following extraction of one central

fraenal attachments, and of these three had open midline sutures and three had closed sutures. Of her three children with normal fraenal attachments, two were X-rayed and showed one with an open midline suture and one with a closed suture, but apparently the third child in this category was an infant not amenable to



Fig. 3.—A, Infant skull showing wide separation of the midline suture. B, Older child with a median diastema but normal intermaxillary suture.



Fig. 4.—Models of the dentition of an East African A compared with that of a European B.

incisor 9 years previously. Ketcham in 1907 confirmed that even in a patient of 24 years, orthodontic approximation of the upper central incisors caused the median suture to close. Ketcham also confirmed that there was no correlation between the presence of what he called an abnormal fraenal attachment and the midline suture; as an example he quotes one mother with such an abnormal fraenal attachment and a wide space between her central incisors but a fused median suture. This lady had nine children, six of them with abnormal

radiographic examination. The late Harold Chapman (1935) also drew attention to this median suture, but did not come to any definite conclusion other than to observe that the crestal extremity of the interdental bone with a patent suture is pointed and where fused is square-ended. It is, however, a subject that would bear further investigation.

POST-FOETAL DEVELOPMENT OF THE DENTITION

In infancy, a space between the recently-erupted deciduous central incisors is almost invariable, but tends to reduce as further teeth erupt. At one time it was considered that so-called 'physiological spacing' developed between the deciduous incisors from about 4 years of age in preparation for the eruption of the wider permanent incisors. Baume (1950) in his study of sixty cases with serial models before, during, and after the eruption of the permanent incisors, found that all cases, where previously the deciduous incisors were spaced, produced properly aligned permanent anterior teeth. On the other hand, half the cases studied by Baume with unspaced deciduous incisors resulted in crowding of the subsequently erupted permanent incisors. Both Clinch (1966) and Leighton (1966) find that there is no sudden spacing of the deciduous incisors between 3 years of age and the eruption of the permanent incisors; in general, they find that if the deciduous incisors are going to be

spaced, then that spacing is present at an early age. Clinch finds that in the deciduous inter-canine distance there is a mean increase of only 0.12 mm. per 10 months from 3 years of age; during the eruption of the permanent incisors the rate increased to 0.69 mm. per 10 months, and, after their eruption, this rate in the inter-canine distance drops to 0.56 mm. per 10 months up to 8 years of age. Friel (1954) and Clinch (1966) have described in detail the changes taking place when the deciduous upper incisors are being replaced by their permanent successors, and point out that as the permanent central incisors erupt downwards and forwards, so the apices of the deciduous central incisors tend to move both labially and distally. Friel goes on to say, 'it is the normal condition for the maxillary permanent central incisors to be spaced when they erupt. They develop spaced, probably because of the septum between the two halves of the maxilla.' This, therefore, re-emphasizes that the midline septum observed by Friel and others could be yet another explanation for upper midline spacing.

AETIOLOGY

1. Inherited Characteristics

When considering the aetiology of persistent midline spaces, there is almost no end to the conditions which could contribute to this.

explained that it was so common in his part of Africa that it could be regarded as almost a normal condition for that area. Apparently his mother and several of his sisters had this condition as well as four of his children. No doubt the large size (*Fig. 4 A*) of the upper dental base in these cases must be a contributory factor.

When, though, all those factors considered to contribute to midline spacing are put together, they might appear as in *Table III*. In 1000 schoolchildren, 278 (or 28 per cent) presented with a significant midline space. Naturally, these shown in this table are not necessarily factors occurring singly, for instance one boy had five of these associated conditions, namely a prominent fraenum, overjet, spacing of all the upper incisors, persistent digit-sucking, and tongue-thrusting.

3. Persistent Labial Fraenum

The oft-quoted factor of persistent labial fraenum obviously cannot be ignored as it comes so high in the list (*Table III*), but, nevertheless, must be regarded as only a contributory factor, since many children possessing a prominent fraenum do not necessarily have a median diastema (*Table IV*). *Fig. 5* is a typical example of a prominent fraenum without a diastema and is in contrast with what we fondly imagine is the inevitable situation. The age-distribution of all cases with a prominent fraenum is shown in

Table III.—CONDITIONS ASSOCIATED WITH A MIDLINE SPACE*
(Total: 278 in 1000)

	WIDTH OF MIDLINE SPACE		
	<i>Up to 1.9 mm.</i>	<i>2.0–2.9 mm.</i>	<i>Over 3.0 mm.</i>
No. having midline space	233	38	9
No. having a prominent fraenum	202	38	8
No. having an overjet	101	10	2
No. having spaced upper incisors	94	12	3
No. with open mouth habit	75	13	1
No. with digit-sucking at time of examination	41	3	2
No. with tongue-thrusting or an overlarge tongue	39	2	1
No. with lower lip behind upper incisors	23	3	1
No. having absence <u>2 2</u>	3	1	—
No. with a mesiodens	—	—	—

* These indicate *occurrences* only; for instance one patient could have at least four of these factors.

Undoubtedly congenital causes, as mentioned by Tait (1929), rank high in the list, and we have all seen parents and offspring with this characteristic.

2. Racial Characteristics

Some *races* show a great disposition to this spacing, as one East African headmaster who

Table V, and, again, the 12, 13, and 14-year-olds appear to have been unduly inconsiderate with regard to the numerical descent or it may be due to the replacement of the deciduous canines. Ceremello (1953) (*Table VI*) in his study of plaster models has shown that no correlation exists between the presence of prominent fraena

Table IV.—AGE DISTRIBUTION OF PROMINENT FRAENA NOT ACCOMPANIED BY DIASTEMATA
(Total: 201 in 1000)

AGE	6 yr.	7 yr.	8 yr.	9 yr.	10 yr.	11 yr.	12 yr.	13 yr.	14 yr.	15 yr.
NON-BLANCHING	12	14	1	4	1	6	6	15	8	2
SMALL +	5	9	14	10	4	9	4	11	4	—
MEDIUM ++	4	5	6	9	5	5	9	6	4	—
LARGE +++	3	—	3	—	—	—	2	1	—	—
EXTRA LARGE ++++	—	—	—	—	—	—	—	—	—	—
TOTAL/YEAR TOTAL	24/87	28/147	24/128	23/115	10/70	20/98	21/98	33/128	16/101	2/28
PER CENT	28	19	19	20	14	20	21	25	16	7

Table V.—AGE DISTRIBUTION OF ALL PROMINENT FRAENA (WITH AND WITHOUT MEDIAN DIASTEMATA)
(Total: 473 in 1000)

AGE	6 yr.	7 yr.	8 yr.	9 yr.	10 yr.	11 yr.	12 yr.	13 yr.	14 yr.	15 yr.
NON-BLANCHING	13	19	1	7	2	6	8	17	13	2
SMALL +	15	29	35	24	6	9	12	14	9	—
MEDIUM ++	22	46	28	18	9	9	14	10	9	1
LARGE +++	15	15	10	6	1	1	3	2	1	1
EXTRA LARGE ++++	6	1	1	1	—	—	—	1	1	—
TOTAL/YEAR TOTAL	71/87	110/147	75/128	56/115	18/70	25/98	37/98	44/128	33/101	4/28
PER CENT	85	75	59	50	26	25	37	34	33	14

Table VI.—SUPERIOR LABIAL FRAENUM, MEASUREMENTS FROM PLASTER MODELS (CEREMELLO)

	NO DIASTEMA				DIASTEMA PRESENT			
	Attach. Height in mm.	Fraenum Width in mm.	Age in Yr.		Attach. Height in mm.	Fraenum Width in mm.	Diastema Width in mm.	Age in Yr.
	4.5	2.0	9		6.5	1.5	1.5	9
	6.5	1.5	12		5.5	2.0	1.5	9
	5.0	1.5	10		8.0	1.0	1.0	17
	4.0	2.0	12		6.5	2.0	1.5	16
	6.5	2.0	14		8.0	2.0	3.0	9
	7.0	1.5	14		5.0	2.0	1.0	14
	5.0	1.5	13		3.0	1.5	1.5	7
	8.5	2.0	13		6.0	1.5	1.0	13
	6.0	1.5	11		5.0	2.5	1.5	19
	7.0	1.0	13		5.5	1.5	1.5	10
	6.0	1.5	15		4.0	2.0	2.5	15
	7.0	1.0	12		4.5	1.0	2.5	8
	5.0	1.5	15		4.5	1.5	1.0	11
	7.0	2.0	12		3.0	1.0	1.0	9
	9.0	2.0	12		5.0	2.0	2.5	9
	9.5	2.0	6		5.0	1.5	1.5	10
	3.5	1.5	10		4.0	1.5	2.0	9
Average	6.3	1.6			5.2	1.7	1.7	
Range	3.5-9.5	1.0-2.0			3.0-8.0	1.0-2.5	1.0-3.0	

and median diastemata. The so-called 'blanching test' (Fig. 6) referred to as early as 1907 by Ketcham, gives some indication of the attachment of fibrous tissues to the anterior palatal papilla. In a transverse section of a prominent fraenum stained with haematoxylin and eosin

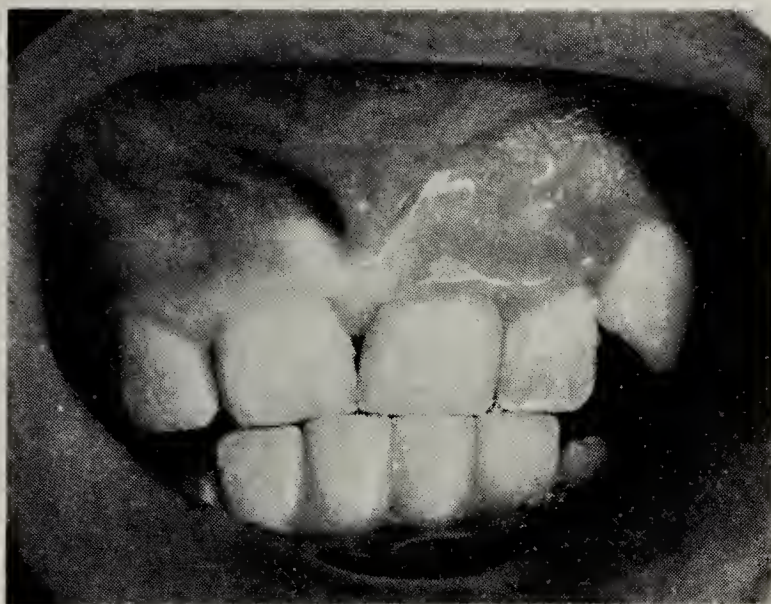


Fig. 5.—A prominent fraenum without a diastema.

the fibrous and connective tissue can be seen in the centre. Where no blanching occurs on stretching the fraenum, the accompanying diastema is not so large, as can be seen in Table VII.

Table VII.—THE RELATION BETWEEN FRAENUM AND DIASTEMA

FRAENUM	DIASTEMA			
	Nil	Under 1.9 mm.	2.0-2.9 mm.	Over 3 mm.
88 Non-blanching	72	12	3	1
153 Small	70	74	8	1
166 Medium	70	81	13	2
56 Large	13	32	9	2
12 Extra Large	—	5	3	4

4. Spacing of the Upper Incisors

The next most common factor following a prominent fraenum is the spacing of the upper incisors, with or without an overjet. This can be attributed to either a small tooth size or to soft-tissue activity, but should be differentiated from the natural so-called 'ugly duckling' spacing of the incisors due to pressure on the incisal root apices from the crowns of the developing canines, or that produced by thumb-sucking. Similarly, the activity of the tongue, or even its size, can produce spacing of the incisors. Other tongue conditions, even though rare, might be associated with dental anomalies, for instance.

5. Partial Anodontia, Extra Teeth, etc.

Other less frequent factors contributing to mid-line spacing are partial anodontia or small-size lateral incisors, and, of course, extra teeth. If you recall Stafne's (1932) survey (Table VIII) almost half the extra teeth occurred in the upper

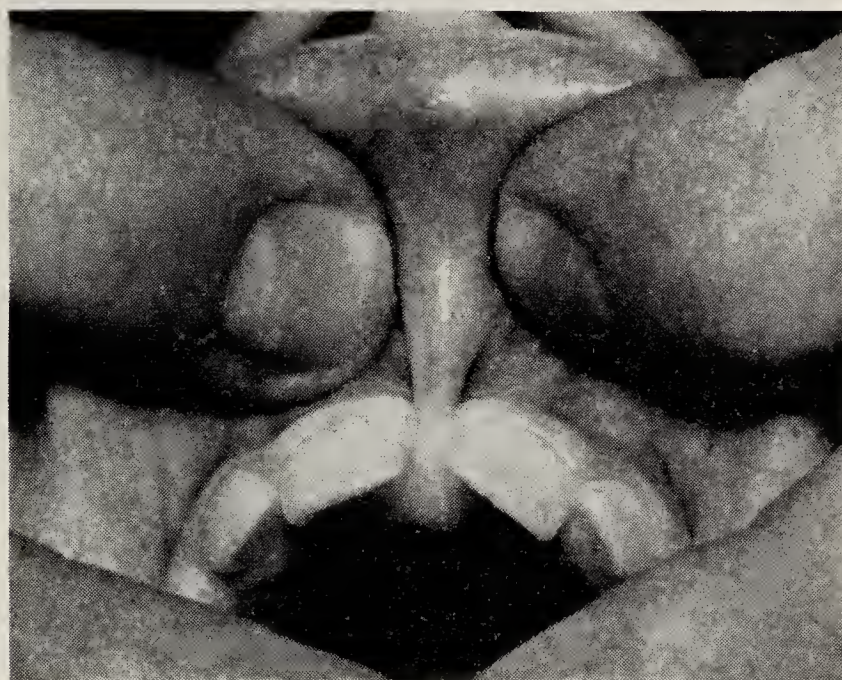


Fig. 6.—'Blanching test' indicating the fibrous nature of the labial fraenum.



Fig. 7.—Effect of a blow in early life on the upper labial region.

central incisor region. Conversely, of course, it is quite possible for supernumerary teeth to occur in the midline without spacing of the central incisors. Odontomes can also produce a similar effect, as also can a dentigerous cyst. There are cases also where trauma can contribute to the midline spaces (Fig. 7) as well as aberrant canines.

6. Results of Orthodontic Treatment

Finally, and I hesitate to mention this, the orthodontist can also be a contributory factor in the causation of median diastemata! In this next illustration for instance (Fig. 8A) a patient having an Angle Class II, division 2 malocclusion attended with a prominent fraenum and a

crossing over of the central incisors. Following the extraction of the upper first premolars and the retraction of the upper canines the patient suddenly developed this marked median diastema (Fig. 8B). Obviously a case where a fraenectomy is indicated.

incisal relation in a matter of nine months. But the vast majority of median diastemata, however, we must admit manage to close without the orthodontist doing a single thing about it.

It would be inappropriate not to mention the removal of a prominent fraenum even though



Fig. 8.—A, Untreated patient with a prominent fraenum. B, Same patient after extraction of $\overline{4}14$ and distal movement of $\overline{3}13$.

Table VIII.—STAFNE'S FIGURES ON THE INCIDENCE AND DISTRIBUTION OF 500 SUPERNUMERARY TEETH

	CENTRAL INCISORS	LATERAL INCISORS	CANINES	PREMOLARS	PARAMOLARS	FOURTH MOLARS	TOTAL
Maxilla	227	19	2	9	58	131	446
Mandible	10	0	1	33	0	10	54

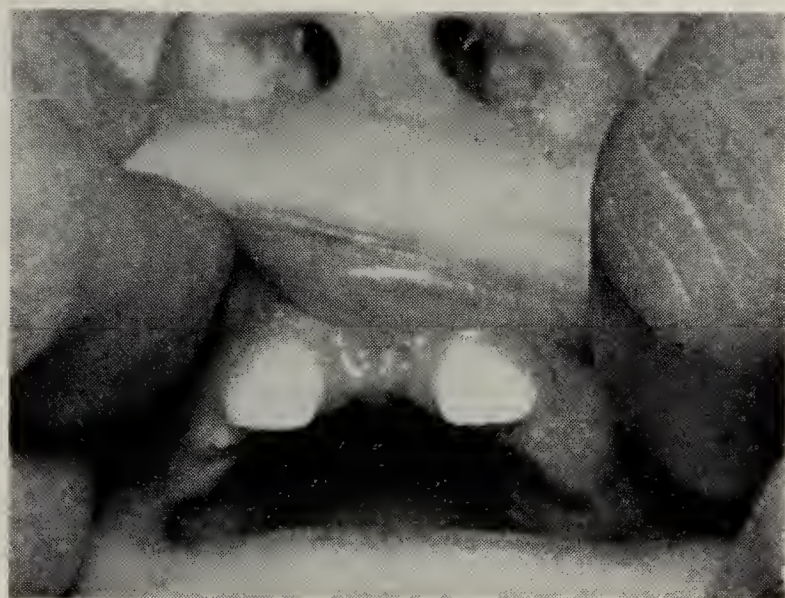
TREATMENT

The treatment of any midline space will naturally depend upon its aetiology. Where the cause is a local one, such as an unerupted supernumerary tooth in the midline, then the obvious step is to remove it. One boy's median diastema closed in about twelve months following the surgical removal of the unerupted mesiodens and did not require the aid of any appliances. Also, in cases such as shown in Fig. 9, the gradual withdrawal of the comforter alone in a child of eighteen months produced a fairly normal

this subject has stimulated so much controversy in the dental literature over the past sixty years. Possibly the biggest error committed in these cases must be in their poor selection, for so many unnecessary fraenectomies must have been carried out. I heard of one enthusiastic paediatric surgeon, one of whose children had developed a median diastema due to a fraenum, and as in his profession he saw children soon after they came into the world, he felt he was conferring a benefit upon humanity if these large fleshy-looking fraena were removed at birth! However, the majority of opinions now seem to be in

favour of delaying a fraenectomy, usually until $11\frac{1}{2}$ or even 12 years of age when the permanent canines erupt and all possible natural pressure from the erupting laterals and canines has been expended on the distal aspect of the central

finally indicated, it should be dissected down to the alveolar bone, and, as recommended by Gillies (1935), the interdental bone resected away from the region of the median suture. Some recommend removing the bone even up to the



A



B

Fig. 9.—A, Wide median diastema in an infant of 18 months associated with sucking a 'dummy'. B, Same patient 9 months after the gradual withdrawal of the 'dummy'.

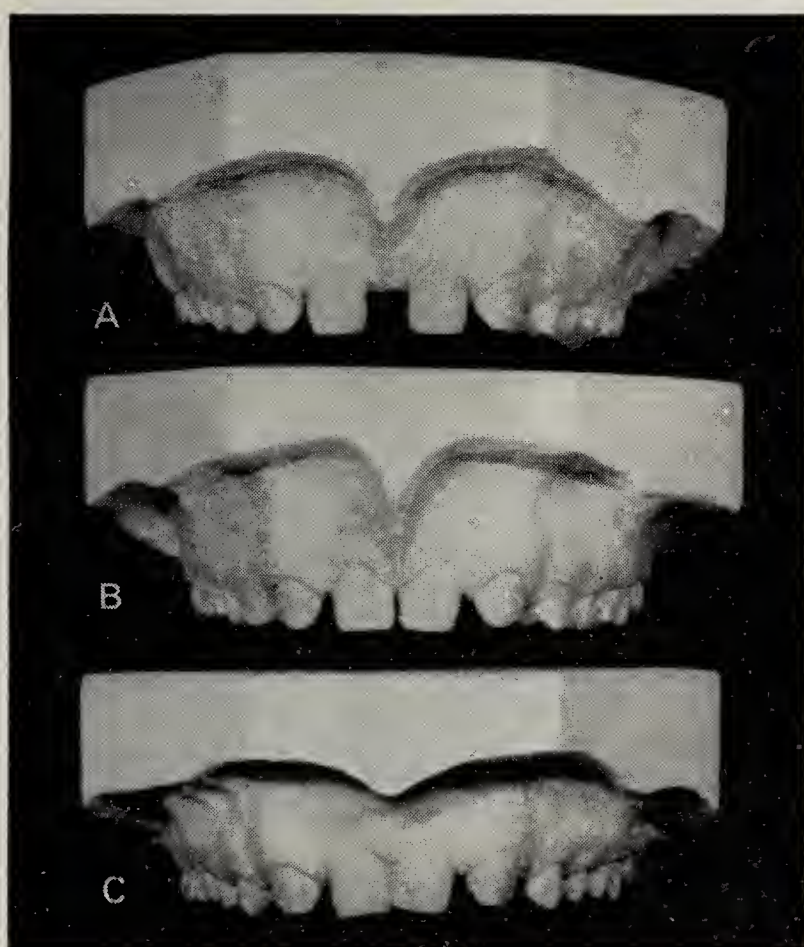


Fig. 10.—A, Patient of 13 years with absence of $\frac{2}{1}2$. B, After mechanical approximation of $\frac{1}{1}1$ but beginning of relapse due to patient not wearing retainer. C, Two and a half months after resecting the fraenum.

incisors. Sometimes the blanching test of Ketcham may help in diagnosing these cases to differentiate between the fleshy-looking, but harmless, fraenum and the fibrous type with its attachment on the ridge anterior to the anterior papilla. Thus, if resection of the fraenum is

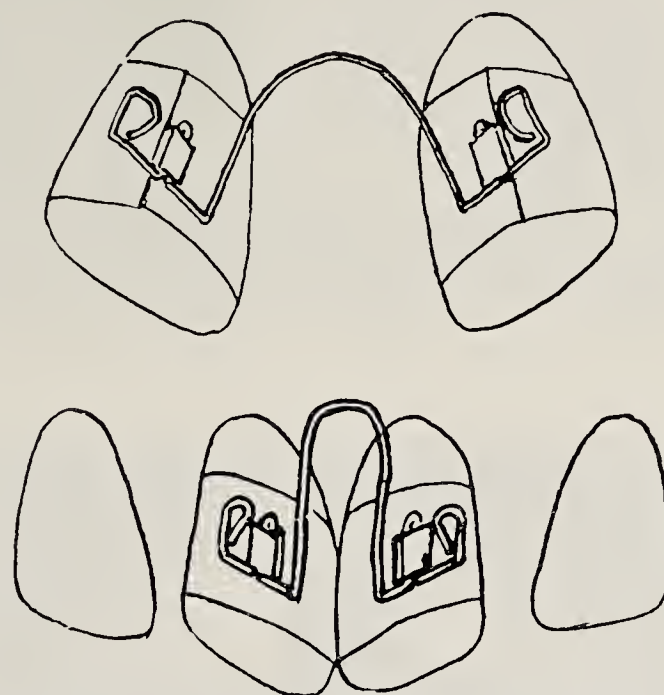


Fig. 11.—Appliance developed by Simon.

level of the apices of the central incisors. (However, at the close of this paper I am hoping to show a short film in which one technique is illustrated for the surgical correction of a prominent labial fraenum.)

Following surgical resection of the fraenum some claim that these median spaces close naturally and there is some evidence for this (Fig. 10), the upper model shows this 13-year-old girl at the beginning of her treatment (for the records of this patient I am indebted to Mr. Dowell of Huddersfield). Radiographs had confirmed that all her third molars and upper lateral incisors were absent. A local appliance was fitted on the central incisors to approximate

them, and this approximation was achieved in six months. However, the patient did not wear her retaining appliance with the result that the central incisors moved apart to the extent of about 1 mm. Dowell (1966) therefore dissected

Should your patient have expensive tastes then the appliance described by Northcroft to this Society in 1912 could be considered; the central incisor bands were made of iridio-platinum and to them was soldered a horse-shoe shaped piece

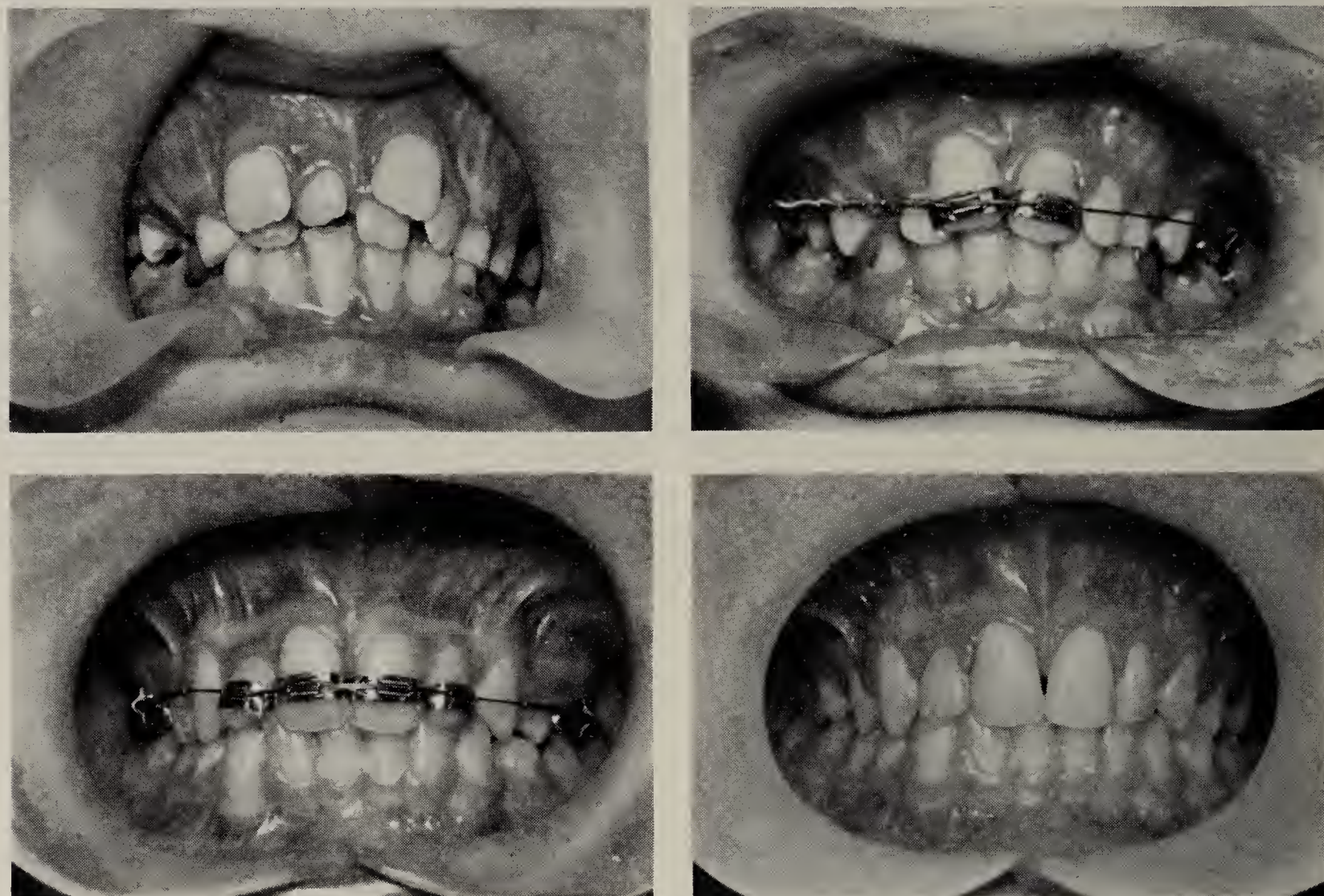


Fig. 12.—Stages in correcting incisors displaced by two supplemental lateral incisors.

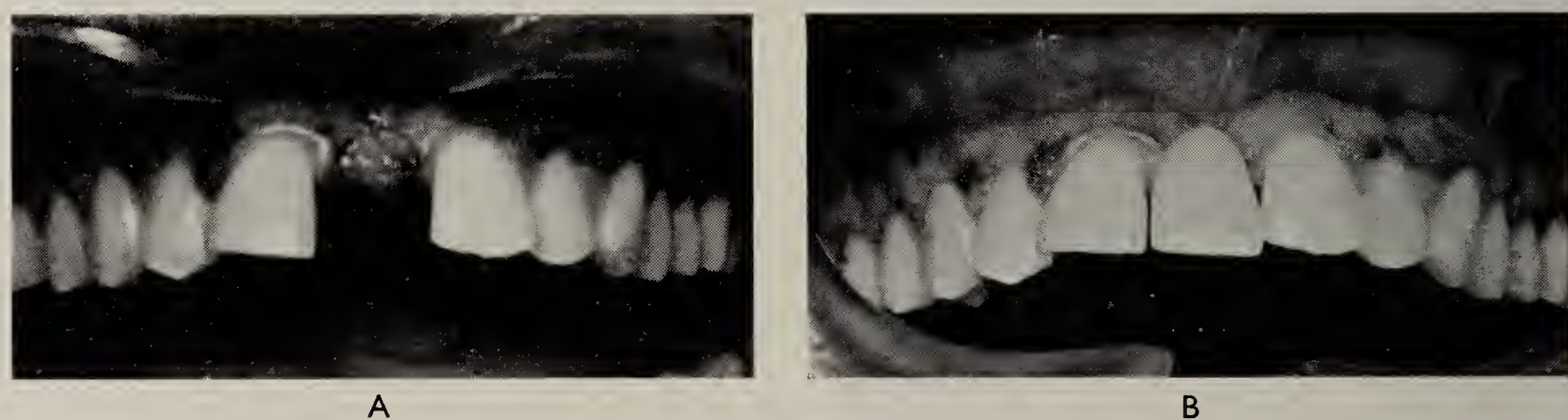


Fig. 13.—A, A very wide median diastema. B, 'Spoon' denture in place.

away the thick fibrous fraenum and *two and a half months later* it was noticed that the central incisors were beginning to cross over (Fig. 10 C).

Even following a fraenectomy some prefer to make sure the interdental space closes by fitting a small local appliance. There is certainly nothing new about these appliances and Farrer, in 1882, published a rather ingenious local screw appliance, going into great detail on the principles involved for the approximation of two spaced incisors.

of No. 7 silver plate. Simon, of Berlin, published the type of appliance shown in Fig. 11 in his textbook of 1933, and this was further developed by Watkin (1933) in his well-known pin-and-tube appliance, although most operators indulge in various shapes of this spring from the simple U-shape to the elaborate heart-shape. An ingenious application of a small coil-spring is used in another local appliance and has the advantage that the teeth cannot be over-approximated. However, following a fraenectomy nothing more

elaborate than a small labial bow can bring about the approximation of the incisors in those cases where there is a prominence of the upper teeth. Coiled springs on a round-wire arch can both reduce any multiple diastemata and also create space between incisors and molars for any impacted canines and premolars (*Fig. 12*). Extra teeth in the midline bring about a variety of mal-occlusions; where the displacement is marked, however, some form of fixed appliance therapy is indicated (*Fig. 12*).

Congenital absence of teeth almost presupposes the provision of a prosthesis of some kind, and in preparation for this the teeth may have to be approximated or repositioned so that, in fact, the denture acts also as a space-maintainer. An overlay type of denture may also have to be considered in some anodontia cases, but the main problem with such prostheses is oral hygiene. An unusual problem was presented by the exceedingly wide diastema in the mouth of this African patient (*Fig. 13A*) and, as the diastema was exactly the width of a central incisor, the obvious solution appeared to be the provision of a supplemental central on a spoon denture (*Fig. 13B*).

(Subsequently a short cine film, made by Mr. Gardiner and Mr. R. C. W. Dinsdale, showed a typical case suitable for fraenectomy. The stages consisted in the inspection procedure, resection of the soft tissue, burring the interdental septum, suturing, the fitting of a local Pin-and-Tube appliance, and packing with the periodontal paste Coe-pak.)

SUMMARY

An account is given of:—

1. The incidence of upper midline spaces;
2. The occurrence of midline space in animals;
3. The foetal development of the upper midline region;
4. The significance of the midline suture;
5. Post-foetal midline spacing;
6. The aetiology of midline space, i.e., inherited characteristics, racial characteristics;

DISCUSSION

Mr. B. C. Leighton, opening the discussion, said that in discussing the incidence of central diastemata, Mr. Gardiner had quoted figures obtained from at least two sources, both of which were based upon cross-sectional data. Not only might a midline space close, but it might close in the deciduous dentition only to reappear in the permanent. He suggested that a study of the incidence of any condition which might be transitory was not complete until a sample of longitudinal records had been examined.

It was common experience to find that spacing of the upper central incisors was the rule at the time that they erupted. This was due in part to the fact

persistent labial fraena, spacing of the incisors, partial anodontia; and extra teeth;

7. Lastly, the treatment of midline spaces.

Acknowledgements

I would like to record my thanks to Miss E. M. Spencer of the Lindsay Library for tracing the references given in this paper; to Professor J. J. Hodson and the Department of Oral Pathology for the preparation of the fraenum section; to Professor Dr. med. E. Hagen of the Anatomy Institute, Rheinischen Friedrich Wilhelms University, Bonn, for the illustrations of child skulls; to Mr. Cousins of the Sheffield Dental Hospital Photographic Department for all the photographs and lantern slide preparations; and also to my friends and colleagues who have helped to make this subject so fascinating.

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that the incisal edge was not usually the widest part of the tooth and partly to separation of the crowns by the intermaxillary suture. As the crowns erupted further, leaving the narrower roots at the level of that barrier, they were able to move together. He could not recall ever having seen even in the most crowded mouths radiographic evidence that either central could invade the opposite half of the maxilla.

He asked Mr. Gardiner whether the animals he had mentioned in fact showed an intermaxillary suture throughout the growing period. It seemed that facial growth in man was unlike that of all other mammals, making it unwise to draw too many

conclusions from studies of other animals. The unusually large amount of vertical growth of the middle face by apposition at the alveolar border in man conferred a considerable capacity for expansion, and seemed to make growth in the midline unnecessary after the first year of life. This was not reflected in other mammals whose faces grew largely in a forward direction, often with apposition in the maxillary-premaxillary suture. It was quite likely that some midline expansion might be needed under those circumstances.

It had been his experience that deciduous incisors only rarely became spaced after they had erupted. Where spacing developed later, it might do so either because generous spaces between laterals and canines had become redistributed between all the incisors, or because the incisors had all moved labially to form a larger arch. There was hardly any absolute increase of intercanine width until the permanent incisors started to erupt.

After an enthusiastic start on fraenectomies he had now become very cautious about them. The loss of not only the fraenum but also the interdental papilla, created an even wider space in the region of the tooth neck. It then became imperative that the space should be closed. If relapse was expected after treatment, this might be prevented sometimes by crowning the lateral incisors with larger crowns. Finally, had Mr. Gardiner any information upon the ultimate fate of fraenectomy cases? Did any of them demonstrate periodontal lesions?

The President asked what Mr. Gardiner did in a case when there was crowding and a space. Sometimes there was a midline diastema between the two centrals, and insufficient space for the canines, and when one condition was treated it tended to exacerbate the other.

There were two other reasons for removing the labial fraenum which had not been mentioned. One was that it was sometimes unsightly in itself and the other that its presence made it difficult for the child to brush its teeth properly.

Mr. G. C. Dickson said that he used to be very much against removing the fraenum. Often the diastema closed without removing the fraenum. It was Dr. Fox at Birmingham who pointed out that there might be very good periodontal reasons for removing the fraenum. If he was hovering in indecision as to whether or not to carry out a fraenectomy he would put a measuring probe down the gingival sulcus to see if it showed any increase in depth in that region, and if there was, there would be very good reason for removing that fraenum for non-orthodontic reasons.

Mr. Gardiner agreed with Mr. Leighton that a long-term follow-up was superior to a short-term one, and obviously revealed much more information.

On the activity in the intermaxillary suture, Larsson, in Stockholm, had done some work on mice, but that was not applicable to human beings. The work of Latham confirmed that in the human being, only up to eighteen months was there rapid growth along the intermaxillary suture, but it declined thereafter, and at two years of age it had the appearance of being inactive.

As to the follow-up of fraenectomies, he preferred to leave that in the capable hands of Mr. James, who would report next month on twelve such follow-up

cases. In those cases where obviously the removal of the fraenum had been clearly indicated, he had not found there to be any periodontal or other reasons to regret the decision.

The President had mentioned the anomaly of crowding plus the midline diastema. Possibly the one could be used to treat the other?

He thanked Mr. Dickson for the observation concerning the periodontal consideration; that was another reason for removing the fraenum.

Mr. A. S. Lewis asked what radiographic evidence Mr. Gardiner used when he decided on removing a fraenum. An inverted V-notch was often quoted as a particular case when removal of the fraenum was essential, and yet the wide diastema seemed to occur when there was that kind of notch or a negligible notch.

Mr. Gardiner replied that the radiographic evidence was a little unreliable. He had tried to correlate the results. Ketcham, in 1907, had found very little to correlate the appearance of the midline suture with the soft tissue state of the fraenum. He preferred to go more on the 'blanching test' and the appearance of the soft tissues.

Mr. F. Allan said that if there was a diastema, and the space was closed and nothing else was altered, was there any correlation between a permanent end-result and a good occlusion and vice versa?

Mr. Gardiner said that sometimes it was a question of redistributing the space. If the midline space was closed by treatment then some other space might be opened distally. It would be a matter of settling with the patient where he wanted the spacing! So often the midline spaces were only one aspect of the occlusal anomaly; there might be five or six others, such as an overjet. The various conditions all had to be treated together.

Mr. C. D. Parker asked if Mr. Gardiner would consider the removal of a section of interdental bone if there was no evidence of a persistent interpremaxillary suture.

Mr. Gardiner said it was doubtful, but he would remove the fibrous tissue down to the alveolar crest. For instance, in the patient quoted, Mr. Dowell not only dissected away the soft tissue, but he also ran a rose-head bur over the alveolar crest to make sure that there was no residual fibrous tissue.

Mr. D. Robertson Ritchie asked whether Mr. Gardiner had any views on why the fraenum should persist. There were some theories—although not put forward very seriously—that most people did not use the upper lip in speaking and that this habit could affect the development of the fraenum.

Mr. Gardiner did not know the answer. He understood that in the animal kingdom among the carnivores, especially dogs, the fraenum was a muscular structure and it was actively used when they were eating.

Mr. D. Seel said that when an appliance is used to approximate central incisors, there is often produced a bunching up of the interproximal gingival tissue. Even if a fraenectomy had been performed previously, at the end of the tooth movements a situation where some gingival trimming may be indicated can thus be produced. This might be an argument for delaying any surgery, including the fraenectomy, in this region until after the completion of the tooth movements.

CLINICAL IMPLICATIONS OF A FOLLOW-UP STUDY AFTER FRAENECTOMY

G. A. JAMES, M.D.S., F.D.S., D.Orth. R.C.S. (Eng.)

Senior Lecturer in Orthodontics, Glasgow Dental Hospital and School

SURGICAL removal of an enlarged superior labial fraenum in young children to assist in the closure of a space between the upper central incisors is now considered to be rarely indicated, according to current orthodontic textbooks. The abandonment of fraenectomy began with Tait's (1929) demonstration that spontaneous closure of a midline space occurs naturally in the majority of children. This observation has since been repeatedly confirmed (Taylor, 1939; Jakobsson, 1962) and undoubtedly a conservative attitude towards surgical interference is fully justified.

Despite this evidence of spontaneous closure developing in most children, there has persisted a belief that fraenectomy is occasionally indicated, although there is some uncertainty as to what might be the indications for surgery (Dewel, 1946; Hovell, 1958, 1966). This uncertainty arises from the difficulty of establishing whether the superior labial fraenum actually does prevent natural closure of the midline space in some children.

It was decided, therefore, that instead of trying to find if there are any indications for surgery during the mixed dentition phase it might be worthwhile attempting a rather different approach to the problem. Accordingly, subjects were chosen for fraenectomy in whom no further spontaneous closure of a midline space could be expected, and they were then followed up for one year after operation. This approach has provided some interesting information concerning the after effects of fraenectomy. In the light of this information, several possible indications for fraenectomy in conjunction with orthodontic treatment can be suggested.

REVIEW OF THE LITERATURE

Ceremello (1953) gives a useful review of the whole subject of the space between the upper central incisors and the superior labial fraenum and concludes that fraenectomy, for orthodontic purposes, is now rarely indicated. Adams (1953) also discusses the question without actually

giving any opinion regarding fraenectomy. Gardiner (1967) has recently examined the problem of the midline space from the comparative, developmental, and clinical aspects.

With regard to the problem of fraenectomy itself one recent report is especially relevant. Bergström and Jensen (1962) selected a group of 40 children aged 8 to 9 years, each of whom had a space between the upper central incisors greater than 1 mm. and an enlarged fraenum which could cause blanching of the incisive papilla when under tension. They matched the children as closely as possible as regards degree of spacing, overbite, overjet, etc., then selected one child from each matched pair and performed fraenectomies on this group, using the remainder as controls. Their surgical technique included scarification of the soft tissues up between the roots of the central incisors. Their results show that fraenectomy actually hastens closure of the space since, after a 2-year interval, 14 of the operated group had complete closure as against only 2 of the matched control group. They conclude that the presence of scar tissue between the teeth is therefore no obstacle to closure, and consider that it is presumably scar tissue contraction which brings the teeth together. However, their experiment does not answer the question of whether fraenectomy is warranted, and, if so, under what conditions, since most of the control group would probably show complete closure as the upper canine teeth erupted.

The literature concerning fraenectomy has another aspect which must be considered. This is concerned with the question of the reaction of the periodontal tissues as a whole to orthodontic tooth movement. Erikson, Kaplan, and Aisenberg (1945) have demonstrated that when two teeth are approximated by an orthodontic appliance, the soft tissues compressed between them do not atrophy after a period of retention, as Angle (1907) has suggested, but persist for many months without a reorganization of the collagenous tissue occurring. Thompson (1955) and Reitan (1959) have discussed this tendency for

the collagenous fibres around the teeth, especially in the gingival area, to persist unchanged following tooth movement. Thompson, Myers, Waterman, and Flanagan (1958) and Thompson (1959) have also investigated the use of surgical modification of the soft tissues after tooth movement is completed. They employed a small number of experimental animals (monkeys) and a small, unspecified number of human subjects. Their procedures included extraction of a central incisor, approximation of the teeth adjacent to the extraction space, and sectioning of the soft tissues mesial and distal to these teeth. Owing to experimental difficulties with the animals used and the small number involved it is difficult to draw from their work any definite conclusions concerning the effectiveness of this surgical interference in minimizing relapse of the teeth.

One other report of particular interest has been made. Ewen and Pasternak (1964) have described a small but carefully controlled experiment involving human subjects. In a group of 5 adolescents, each of whom had a sizeable space between the upper central incisors, they closed the space by orthodontic means, then maintained the central incisors in contact. Following the removal of the apparatus there was considerable relapse of the upper central incisors, as might be expected. They then reclosed the space and immediately performed a modified gingivectomy around the upper incisors. This gingivectomy included a fraenectomy in those instances where the fraenum was enlarged. The appliances were removed after a short retention period. Relapse this time was nil or at most very slight. They conclude that the possibilities of surgical intervention after tooth movement are promising, but they point out that surgery is probably best reserved for situations where the orthodontist's experience suggests the chances of relapse are high. Surgery is no substitute for correct orthodontic treatment, but may be a useful adjunct.

MATERIALS AND METHOD

For this investigation patients were selected in whom all the permanent teeth except the third molars had erupted, i.e., a sample similar to that of Ewen and Pasternak in that a relatively stable dentition had been achieved. The age range was 12–22 years, with most of the subjects in the 12–15 year group. All 10 subjects were female, but this was not considered a point likely to affect the results. Although some of the subjects had received orthodontic treatment at some time prior to fraenectomy, they had been out of retention for at least 6 months before the fraenectomy and could be considered as likely to have achieved stability of tooth position. Care was taken during the follow-up period to study the occlusion as a whole to detect any

possible relapse towards the original malocclusion, but this did not seem to occur in any instance. No orthodontic treatment was given after the fraenectomy.

All the subjects had an enlarged superior labial fraenum, with an extension through between the incisors to the incisive papilla. Blanching of the palatal mucosa could be achieved by putting the upper lip under tension. The thickness and length

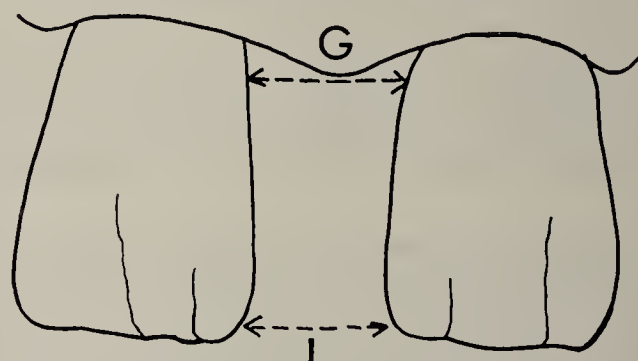


Fig. 1.—Diagram showing points at which measurements of the upper midline spaces were made, I being at the mesioincisal corners and G at the gingival margins.

of the fraenum was otherwise quite variable, as was the angulation of the central incisors to one another.

The first 2 subjects selected for this investigation were operated on primarily with a view to improving the gingival condition and removing an unsightly soft tissue mass from between the upper central incisors. However, the changes in tooth position which followed the surgery seemed to warrant further study.

Study models and radiographs were obtained in each case immediately before operation and further study models were taken 3 months, 6 months, and 1 year afterwards. Radiographs were repeated 1 week after operation, then 6 months and 1 year after.

The technique for measuring the space on the models between the upper central incisors was a modification of the method used by Bergström and Jensen (1962). They simply recorded the minimum distance between the central incisors, and on subsequent models taken they made the measurement at the same level from the incisal edges. In this investigation it was decided to use two measurements for each space, one at the mesioincisal corners and one at the gingival margins (Fig. 1). To ensure accuracy, subsequent to operation, the later gingival measurements were made at the same level on the teeth as the original models. This double measurement permits a more accurate estimation of lateral tooth movements.

To measure a space of less than 1 mm. suitable gauges of round stainless-steel wire were used and for a space greater than 1 mm. vernier callipers were employed. All measurements were repeated on the models 1 week and 1 month afterwards to assess measurement error. This

error tended to be greater on the larger spaces, but the technique proved to be accurate within 0.2 mm. in all instances. Where a discrepancy did arise, the measurements were re-checked. It was found, however, that a change of 0.2 mm. or more was readily detectable by eye.

operation, the fact that some change of tooth position could be observed in all 10 cases is of interest. However, the results are far from uniform and therefore a brief review is given of each subject. They are arranged in increasing order of size of the midline space.

Table I.—SHOWING SIZE OF THE $\overline{111}$ SPACE, MEASURED IN MILLIMETRES, AT THE GINGIVAL MARGINS (G) and MESIOINCISAL CORNERS (I)

SUBJECT		BEFORE OPERATION	3 MONTHS AFTER OPERATION	6 MONTHS AFTER OPERATION	1 YEAR AFTER OPERATION	NET CHANGES AFTER 1 YEAR	
						Closure	Opening
J.B.	G. I.	0.8 0.7	0.6 0.5	0.3 0.2	0.0 0.0	0.8 0.7	— —
W.G.	G. I.	0.7 0.4	0.7 0.2	0.3 0.1	0.1 0.0	0.6 0.4	— —
H.W.	G. I.	0.9 1.2	0.8 1.0	0.8 1.2	0.8 1.4	0.1 —	— 0.2
S.H.	G. I.	1.3 1.1	1.3 1.1	1.2 1.1	1.1 1.1	0.2 —	— —
P.C.	G. I.	1.4 1.2	1.4 0.8	1.3 0.9	1.2 1.0	0.2 0.2	— —
P.K.	G. I.	1.3 2.8	1.2 1.7	1.0 1.7	1.0 1.7	0.3 1.1	— —
M.G.	G. I.	1.8 2.1	1.7 1.3	1.5 1.3	1.5 1.3	0.3 0.8	— —
M.M.	G. I.	2.0 2.4	1.4 2.0	1.4 2.2	1.5 2.5	0.5 —	— 0.1
H.F.	G. I.	2.1 2.4	2.2 2.5	2.2 2.5	2.3 2.7	— —	0.2 0.3
V.A.	G. I.	3.2 3.3	3.0 3.3	3.2 3.3	3.2 3.3	— —	— —

The fraenectomy technique employed was that described by Hovell (1958). The wound on the inner aspect of the lip was kept as small as possible, thus minimizing postoperative discomfort. Scarification of the apical area between the upper central incisors was done by means of a fine fissure bur extended as high up as was possible without damaging the tooth roots. The technique was standardized as much as conditions permitted. Gingivectomy instruments were used since these provide better control of the wound edges.

RESULTS

The results are summarized in Table I. In view of the deliberate choice of subjects in whom stability seemed to have been achieved before

Subject J.B. Complete closure was observed after one year. The long axes of central incisors were parallel before operation and appeared to remain so after closure.

Subject W.G. Following removal of the fraenum the space closed completely at the incisal edges although a slight space was detectable at the gingival margin. The central incisors were slightly mesially inclined before the fraenectomy and no obvious change in their axial inclination was apparent one year after operation.

Subject H.W. This patient had slight distal tipping of $\overline{111}$ before operation. One year after operation this tipping had worsened very slightly with an actual increase in width of 0.2 mm. at the incisal level and a decrease of 0.1 mm. at the gingival level.

Subject S.H. $\overline{111}$ were slightly mesially inclined before operation. Slight closure was just detectable

clinically, together with an uprighting of the central incisors.

Subject P.C. $\overline{111}$ were slightly mesially inclined before operation. 0.2 mm. closure occurred without any detectable alteration in the axial inclinations of the teeth.

Subject P.K. (Fig. 2). $\overline{111}$ were markedly divergent before operation. This divergence had diminished

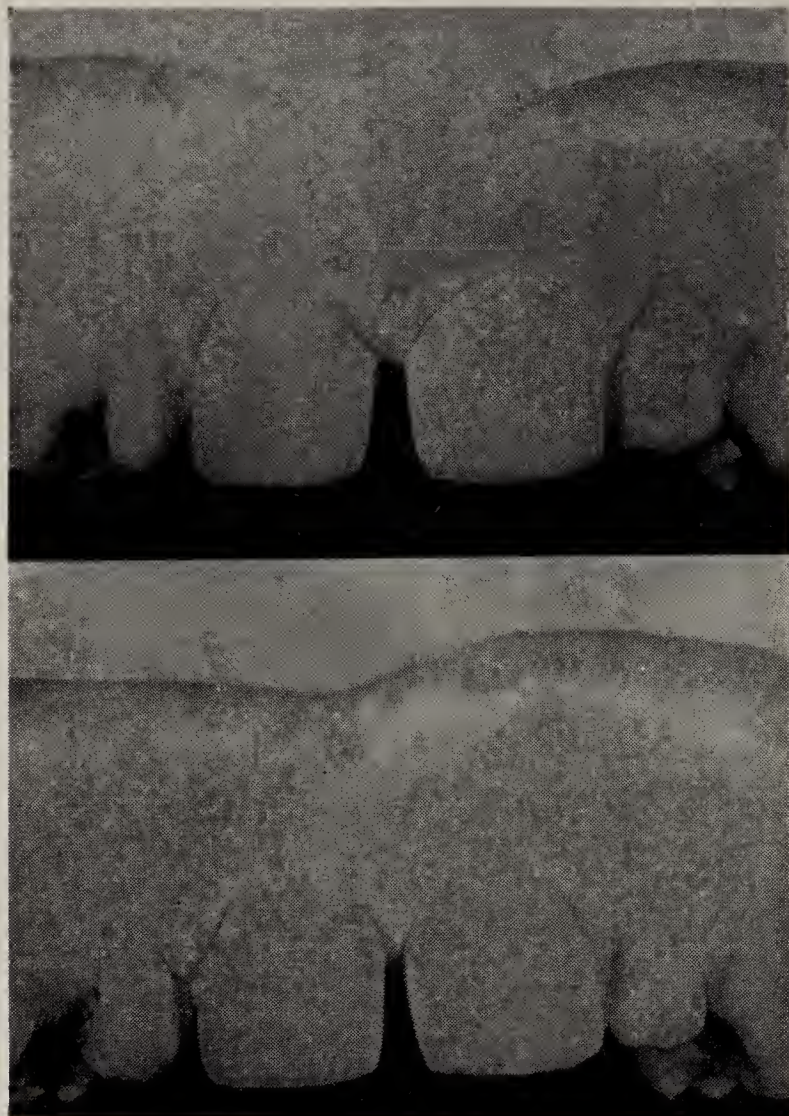


Fig. 2.—Subject P.K. Preoperative and one year postoperative models showing reduction in midline space. Closure has occurred principally at level I. (See *Fig. 1.*)

noticeably after one year, as considerable closure (1.1 mm.) took place at the incisal level, but only 0.3 mm. closure at the gingival level.

Subject M.G. This subject had one of the rather larger midline spaces, with $\overline{111}$ being vertical before operation. Partial closure occurred, with the upright inclination altering to a slight mesial inclination.

Subject M.M. (Fig. 3). Some divergence of $\overline{111}$ was present before operation. This was more pronounced one year after the fraenectomy. Actual closure at the gingival level amounted to 0.5 mm., but the incisal distance remained virtually the same, hence the increased divergence.

Subject H.F. The space one year after operation had increased perceptibly, with little change in the nearly parallel long axes of the $\overline{111}$. This worsening of the space cannot readily be accounted for. There did not seem to be any detectable change in the overbite or overjet. The patient had previously received treatment for correction of an Angle Class III malocclusion and it is possible that the upper incisors

became further proclined during the follow-up study. Unfortunately, lateral skull radiographs were not available for the relevant period to allow this supposition to be checked.

Subject V.A. The oldest subject in the investigation, with a considerable midline space. Fraenectomy was performed primarily for aesthetic reasons but after three months a slight degree of closure was noted.

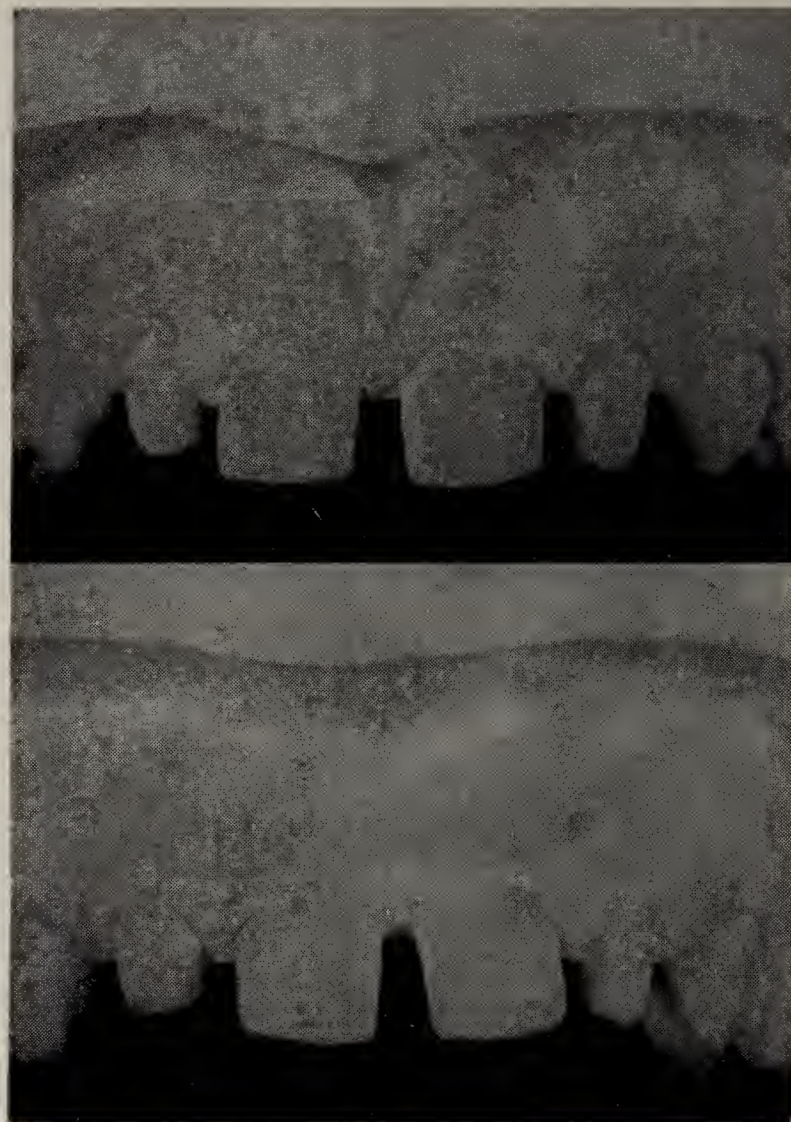


Fig. 3.—Subject M.M. Preoperative and one year postoperative models. Reduction in width of the midline space has been confined to the level G and there has been a very slight increase at level I. The result is increased divergence of the $\overline{111}$. (See *Fig. 1.*)

This proved to be transient and the condition after one year was identical to the pre-operative state.

In each case the overall state of the periodontium one year after operation was excellent and it could fairly be claimed that as regards this aspect a definite improvement in the periodontal condition and appearance was obtained in all instances.

The radiographs showed that bony changes following operation tend to be a loss of the typical V-shaped notch present on the alveolar crest in the midline of the majority of the subjects. The scarification produced a blurring of bony outlines on the immediate postoperative radiographs, but the crest was well established again one year afterwards. There appeared to be a tendency for the edge of the suture to close over postoperatively, as Gardiner has already observed.

DISCUSSION

The subjects in this experiment were deliberately selected to try to eliminate the possibility of spontaneous closure of the midline space due to pressure of erupting teeth. The postoperative changes in the upper central incisor relationship are, therefore, almost certainly due to the surgical interference. Since all the subjects had spacing of the upper arch elsewhere as well as in the midline, or at least had an absence of crowding, it seems unlikely that the observed reaction was due to the presence of a mesial component of force coming into play once the physical barrier of the fraenum was removed. It is suggested, therefore, that it is the creation of scar tissue and its subsequent behaviour which is responsible for the observed tooth movements.

Before discussing scar tissue in this particular region, it is worthwhile considering some of the known characteristics of scar tissue in general (Abercrombie, James, and Newcombe, 1959). Several factors may affect its behaviour. One of the most important is the site of the wound. If this is in an area of loosely attached soft tissues, there is a much greater tendency for the edges of the wound to come together, whereas if the soft tissues are firmly attached to underlying hard tissues, this tendency to closure is much reduced and there is, accordingly, a greater amount of scar tissue formation. Secondly, the period of maximum contraction in loosely attached tissues is during the first 6 weeks after operation and thereafter there is a considerable slowing up of the process. Again, the site is important. Contraction is continued over a longer period of time where the tissues are more firmly attached. Finally, once the contraction phase has been completed there may be a partial relaxation of the scar tissue.

It is helpful to keep these points in mind when considering the results of the present investigation. Despite the very firm attachment of the teeth and the periodontal soft tissues, factors tending to resist closure of the space, the contraction of the wound was sufficiently powerful to produce some tooth movement. It achieved an approximation of the central incisors in the two subjects (*J.B.* and *W.G.*) with the smallest spaces and some contraction in seven more, although in one subject (*H.F.*) the space actually increased. A tentative explanation has been advanced to explain this isolated instance. It is apparent that in most instances the contractile element must be a powerful one. In general terms it is most effective in causing tooth movement where the space is small, i.e., 1.5 mm. or less.

The rate of contraction is also affected by the firm attachment of the tissues involved and contraction proceeds at a much slower rate than in loose soft tissue. Even after 6 months

several subjects continued to show a diminution of the space. Observation of other, more recent, cases where fraenectomy has been done as tooth movements were completed suggests that closure can be rather more rapid if the teeth are relatively mobile.

The relaxation factor in scar tissue may account for the slight widening seen in *Subject V.A.* after an initial contraction phase. It is just possible that a further period of observation of the other subjects might show some widening in cases where contraction only had occurred up to the end of the observation period.

Despite the fraenectomy technique having been as consistent as possible, the extent to which interdental scarification was possible was affected by the size of the space and the angulation of the central incisors. This variability probably accounts for the difference in tooth movements noted. For example, in *Subject P.K.* (*Fig. 2*), although there was originally considerable divergence of the incisors the proximity of their roots did not permit scarification to be extended apically to any extent. Tissue removal and subsequent scar tissue formation were therefore confined to the gingival area. The tendency of the I|I to become more upright is therefore probably the result of the wound being limited in this way. Similarly, in *Subject M.M.* (*Fig. 3*), access between the apices was easily obtained, the resultant wound extended quite high up between the apices, and in this instance the roots tended to approximate more than the crowns. It seems, therefore, that the distribution and size of the interdental wound may be significant in varying the axial inclination of the central incisors.

It is possible, as a result of this investigation, to obtain some idea of the results of fraenectomy when isolated from any complementary orthodontic treatment or from the effects of adjacent erupting teeth. These results certainly do not support the possibility that fraenectomy is indicated as a routine procedure wherever the fraenum is enlarged and a midline space is present. Nor do they solve the problem of whether fraenectomy, independent of orthodontic treatment, is ever justified during the mixed dentition phase. As regards this point it is the author's opinion that it is likely to be very difficult to establish criteria for this procedure.

What the results do show is that there is a variable element of closure of the midline space following surgical removal of the superior labial fraenum, despite the firm attachment of the teeth to the supporting alveolar process. The wider the space is, the less effective will be the contractile reaction in achieving tooth movement. There is also a possibility that the actual fraenectomy technique has an influence in deciding what type of tooth movement will result.

The question arises, therefore, as to whether there are occasions where fraenectomy, associated with orthodontic treatment, could be advantageous. It is suggested that there are such occasions, but before discussing possible indications for fraenectomy the question of timing must be considered. If it is scar tissue reaction which accounts for the observed tooth movements after fraenectomy it follows that the surgery should be arranged to utilize this reaction. If the central incisors are to be approximated or rotated as part of orthodontic treatment it will take some months to accomplish this tooth movement. If the fraenum is removed before this orthodontic treatment then the period of maximum scar tissue contraction will have passed before the teeth are aligned. Furthermore, there may well be a heaping up of scar tissue as the teeth are approximated, thus creating conditions making for possible relapse.

On the other hand, if the teeth are first aligned and the fraenectomy is timed to coincide with the completion of the tooth movements then the main contraction phase occurs as the retention of the teeth is begun. At the same time, the fraenectomy removes the mass of resistant fibrous tissue which has been compressed between the teeth and helps bring about a reorganization of the interdental soft tissues.

This concept of fraenectomy after and not before tooth alignment is not a new one (Dewel, 1946; Ewen and Pasternak, 1964), but has only recently begun to receive serious consideration. It places fraenectomy in the same category as Ewen and Pasternak's post-treatment gingivectomy by inducing a reorganization of the supra-alveolar periodontal tissues. The question of surgical modification of the soft tissues after orthodontic treatment is one which will certainly have to be further investigated in view of recent findings on the histological aspects of tooth movement. The present investigation suggests that there may be a useful place for such surgery, in suitable circumstances.

Some possible indications for the removal of an enlarged superior labial fraenum are now listed. Of course, as Gardiner (1967) has pointed out, the existence of an upper midline space is often very acceptable to the patient, in which case it may be best to accept this. In all the instances given below it is assumed that the upper central incisors have been approximated and their axial inclinations corrected before the fraenum is removed. Fraenectomy is envisaged as part of a comprehensive orthodontic treatment plan rather than an isolated procedure:

1. Where the upper central incisors are divergent or rotated or both.
2. Where one or both upper lateral incisors are absent and it is necessary to close a midline space before inserting a removable prosthesis to replace one or both laterals.

3. Where an enlarged midline space in an Angle Class II, division 1 patient fails to close during retraction of the upper labial segment.

4. Where a midline space develops during the course of orthodontic treatment although no space existed before treatment was begun, e.g., after extraction of the upper first premolars.

5. In the small group of patients in whom an upper central incisor has been lost and it is feasible to close the resulting space rather than insert a prosthesis.

In each instance the fraenectomy technique should be adapted to the individual requirements of the case, e.g., where the upper central incisors are divergent before orthodontic treatment then scarification should be confined to the gingival region to minimize any tendency for the apices to be approximated during healing.

Findings in a number of subjects currently being treated in this way are very encouraging, although the number of completed cases is as yet small.

SUMMARY

1. An enlarged superior labial fraenum was surgically removed in 10 human subjects all of whom had an upper midline space and had achieved a full adult dentition prior to operation.

2. No orthodontic treatment was associated with the fraenectomies. Changes in the dentition subsequent to operation were recorded by taking study models at set intervals over a 1-year period and comparing them with preoperative models.

3. The response following surgery was not uniform but 8 out of 10 subjects showed some degree of closure of the upper midline space. One subject showed no change after 1 year, and the remaining subject had an increase in width of the space.

4. Factors associated with the changes recorded are discussed in the light of tissue reaction elsewhere in the body.

5. It is argued that surgical removal of an enlarged superior labial fraenum in conjunction with orthodontic treatment may be justified, but that fraenectomy should be done after and not before approximation of the upper central incisors.

6. Specific indications for fraenectomy in association with orthodontic treatment are suggested.

Acknowledgements

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and has permitted me to publish material from his department.

Mr. A. Cockburn, Orthodontic Consultant, Glasgow Dental Hospital, has offered constructive criticisms and Mr. I. Murray, Medical Photographer, Glasgow Dental Hospital, has assisted in preparing the material for publication.

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DISCUSSION

Mr. E. S. Broadway said he was very pleased to hear that the cutting of tissue and removal of bone produced scar tissue. The movement of teeth was, in fact, caused by contraction of the scar tissue. He thought that the point about the removal of the fraenum after tooth movement was worth following up, if only for the one very good reason of the bunching of the tissues following such treatment.

Mr. C. D. Parker said that Mr. James had not mentioned persistence of the interpremaxillary suture. He asked if the reason was that the suture was thought to be insignificant.

Mr. James, in reply, said that he had taken an enlarged superior labial fraenum as the chief indication rather than whether or not the interpremaxillary suture was open. From the postoperative results it would seem that the portion of the suture at the alveolar crest could close up or at least reduce considerably in width when the fraenum was removed and scarification was done. Possibly, therefore a wide suture before operation might be an indication for scarification to ensure a reaction across the suture.

Mr. F. Allan said that he did not do fraenectomies but wondered whether there was more reason now for doing fraenectomy.

In reply, Mr. James wondered whether he had failed to make clear in his presentation that cases suitable for fraenectomy were very limited in number.

Mr. Allan asked whether it was one in a thousand, or what?

Mr. James suggested that over the past 18 months, using the criteria he had indicated, he doubted if more than two dozen fraenectomies had been done in what was a relatively large department. Cases were selected very carefully and it was not intended to suggest that fraenectomy would have more than a limited, carefully defined, place in treatment.

Mr. T. Smith was reminded of a patient from whom he had extracted both upper second premolars, following which a median diastema developed. He had removed the fraenum and moved the anterior teeth together, warning the girl that there might be residual spacing at the sides of the mouth, but in 3 months all the spaces had closed.

Mr. James said that such a reaction was always a possibility, but it was generally agreed, on a basis of clinical experience, that the space would probably open up again. The post-treatment fraenectomy

creates a tissue reaction which helps maintain the teeth in contact.

Mr. P. Vig wondered whether Mr. James had considered that fraenectomy in the cases of the very large fraenum may alter the activity of the upper lip on the upper incisors. Perhaps this increased activity was responsible for space closure in such cases?

In reply, Mr. James agreed that, following fraenectomy, there could be increased lip activity, but it was difficult to establish that such a change in behaviour had occurred.

Dr. J. R. E. Mills said that very little seemed to be known about the histology of midline spaces. The teeth were normally joined to each other by trans-septal fibres, but he felt that in many cases these probably did not run between the upper central incisors; the suture intervened and the trans-septal fibres were essentially a part of the periosteum, which did not cross the suture. The central incisors were held in contact by mesial pressure from the laterals, and in the absence of this pressure there was nearly always a median diastema. With the removal of the suture it might be that the scar tissue took on the function of the trans-septal fibres.

He remembered that in a group of Saxon skulls described by Miss Smyth there was one with a large median diastema, and this was associated with a very wide suture—it almost looked as though the premaxillae, growing out from their centres of ossification, had failed to meet.

Mr. James, in reply, said that in the case of trans-septal fibres across the midline he did manage to obtain a post-mortem specimen showing trans-septal fibres apparently extending across the midline. However, only one specimen was examined and as a mild periodontal condition was present clinically any such findings were suspect.

As to the suggestion that separation of the two parts of the premaxilla might represent a developmental failure, such a variation, in man, was feasible from a phylogenetic point of view. It was not likely in other species of Haplorhine Primates, but could be observed as a normal pattern in the Strepsirhine Primates. The existence of a very large space between the bony portions of the premaxilla might make the hopes of obtaining a complete and permanent closure of an interdental space much less, despite fraenectomy and interdental scarification.

THE UNERUPTED INCISOR

A STUDY OF THE POSTOPERATIVE ERUPTIVE HISTORY OF INCISORS DELAYED IN THEIR ERUPTION BY SUPERNUMERARY TEETH

R. D. HOWARD, B.D.S., F.D.S., D.Orth. R.C.S.

Senior Lecturer in Orthodontics, King's College Hospital Dental School, London

SUPERNUMERARY teeth are the commonest cause of delayed eruption of the permanent incisors. This fact, and the necessity for the removal of the supernumerary teeth in these circumstances as one of the first stages of treatment, is widely known. That some teeth do not then erupt, but require further surgical intervention, is equally well known but less often discussed.

The present study was undertaken in an attempt to assess the incidence of these cases

Table I.—SHOWING DIVISION OF MAIN GROUPS

	<i>Cases</i>
No abnormality of permanent incisors	18
Displacement and/or rotation of incisor(s)	10
Delayed eruption of incisors	42

and, if possible, the aetiological factors involved as well as devising a technique for their management.

The sample consisted of 70 cases admitted to King's College Hospital by the Orthodontic

also any differences or similarities that may exist between these and the other cases.

Table I shows the number of cases in each of the main groups into which the sample was divided. The division of cases was made in this way at least in part so that comparisons could be made with two other studies involving supernumerary teeth made recently. The figures of all these studies have been turned into percentages so that direct comparisons may be made in each group (some simplification of both Gardiner's (1961) and Day's (1964) groups has had to be made).

In *Table II* it will be noted that there appears to be little similarity in the figures of the three studies. In the Gardiner sample the largest group was that in which the incisors had erupted but showed some irregularity, whereas in the present study the largest group was that in which the incisors were delayed in eruption. The Day sample is somewhat in between these with regard to numbers, since both of these groups appear to be nearly equally well represented. A

Table II.

	<i>Gardiner 1961</i>	<i>Day 1964</i>	<i>Howard 1966</i>
No abnormality	7 per cent	20 per cent	26 per cent
Displacement/rotation	63 per cent	37 per cent	14 per cent
Delayed eruption	28 per cent	39 per cent	60 per cent
Miscellaneous	3 per cent	4 per cent	0 per cent

Table III.

	<i>Gardiner</i>	<i>Day</i>	<i>Howard</i>
Cases of delayed eruption	28 cases	31 cases	42 cases

Department for the removal of supernumerary teeth during the years 1960-66. Not all of the cases involved had delayed eruption of the incisors, or indeed any abnormality in the incisor region at all, but it was necessary to examine them all to determine not only the incidence of the cases under examination, but

small measure of agreement exists between the Day and the present study with regard to the groups in which no abnormality of the incisors was found.

Table III shows a comparison of the number of cases in the delayed eruption group in each of the three studies.

Presented at the meeting held on 12 December, 1966.

DELAYED ERUPTION GROUP

Surgical Procedure

The method of treatment of these cases was substantially the same and followed what is believed to be current practice.

A mucoperiosteal flap was reflected under endotracheal anaesthesia and the area of bone covering the site of the supernumerary tooth exposed. The bone was then pared down to these teeth using burs and, after positive identification, the supernumerary tooth removed.

The bone occlusal to the incisal edges of the permanent incisors affected was then removed, but no attempt was made to free the whole of the clinical crown of bone. The wound was then closed in those cases where the incisors were deep seated, or sutured open where the incisor was more superficially placed.

The surgical technique described is somewhat midway between that of Hovell (1958), who advocates complete exposure of the crown of the incisor and packing the wound open, and Day (1964), and Broadway and Gould (1960) who feel that no exposure of the crowns of the incisors should take place at this stage.

It is perhaps interesting to note that Gardiner, quoting Stoy, has drawn our attention to the fact that exposure of the incisors without removal of the supernumeraries may still result in eruption of the incisors.

Postoperative History

Whichever technique is followed it appears that the majority of incisors do erupt satisfactorily following the removal of supernumeraries, subject to the space requirements being met.

The present study is concerned with the small group in which the incisors do not erupt satisfactorily and require further surgical intervention at a later date. This group has been termed the 're-operation group'.

The literature is rather sparse on this particular group and most of the references are oblique, mention being made *en passant* in either the studies on supernumerary teeth or their treatment. Gardiner, in his 1961 paper, mentions that some cases of badly displaced teeth may require further intervention, and quotes two cases. Day states that in all his cases the incisors were in a favourable position for eruption, and describes one case that required a second operation. Burke, in his 1963 investigation of the rate of eruption of incisors delayed in their eruption, describes a series of 22 cases, 10 of which required re-operation. In addition, case reports of individual cases do occur, usually with reference to details of their management, but it appears that apart from the Burke study, these cases as a group have received little attention from the aetiological point of view.

RE-OPERATION GROUP

The number in this group was small, consisting of 10 cases, and it is proposed to analyse these in some detail.

They were examined in three main respects: (1) General factors; (2) Factors relating to the supernumerary teeth; (3) Factors relating to the unerupted incisors.

1. General Factors

a. Age

The age range of the patients in the re-operation group was not unusual, 9 out of the 10 cases falling into the 8–11 age-group which covered 20 out of the 32 patients in the delayed eruption group and 50 out of the total sample.

b. Sex

The sex representation was approximately the same as that of the delayed eruption group and total sample.

c. Skeletal Pattern

No unusual representation of skeletal patterns was found.

d. Crowding

Crowding of a degree necessary to warrant the extraction of 2 upper units was present in 7 out of the 10 cases in this group. The same proportion of cases required extraction in the rest of the delayed eruption group (19/32) and the erupted group (20/28).

The degree of crowding also appeared to be about the same in the groups mentioned.

That crowding plays an important part in preventing or slowing the eruption of incisors is not questioned, in fact Burke has been able to show by using a very precise technique by how much in terms of millimetres per month an incisor may be slowed by the presence of crowding. Crowding in the group of cases under discussion, and, indeed, in this type of case in general, is almost certainly not the prime factor, since a characteristic feature of these cases is the failure by the tooth to erupt, even when sufficient space has been created. It may, however, play a part in the early stages of treatment of those cases in the delayed eruption group.

2. Factors Relating to the Supernumerary Teeth

a. Number

Since 2 cases had 2 supernumeraries and 1 case had 4 supernumeraries in this group it was thought that this might be a factor of some importance, but examination of the delayed eruption group revealed 13 cases having 2 supernumeraries and 1 case of 4 supernumeraries. Only 5 cases involving 2 supernumeraries were, however, found in the erupted group. It would appear from this small representation in the latter group that multiple supernumeraries may

predispose to delayed eruption if not to re-operation.

A consideration of the number of supernumeraries without an accompanying consideration of the form of these teeth is probably rather misleading, since the form of the paired supernumeraries already discussed in the erupted group differed considerably from that of those involved in the re-operation group.

b. Form

The variety of size and shape of supernumerary teeth at first examination appears to represent a

re-operation group. In *Fig. 1A* one of these cases is shown in which two supernumeraries of this type were found, one in association with $\underline{11}$ and the other rotated through 90° in association with $\underline{11}$. A simple, peg-shaped supernumerary was present in the apical region of $\underline{11}$, and a further supernumerary of the next type to be discussed was also found in association with $\underline{11}$. It may be noted that, in addition to a considerable distal and labial displacement of the crown of $\underline{11}$, there is also a marked displacement of $\underline{11}$ apex towards the midline. This marked apical displacement will prove to be a constant

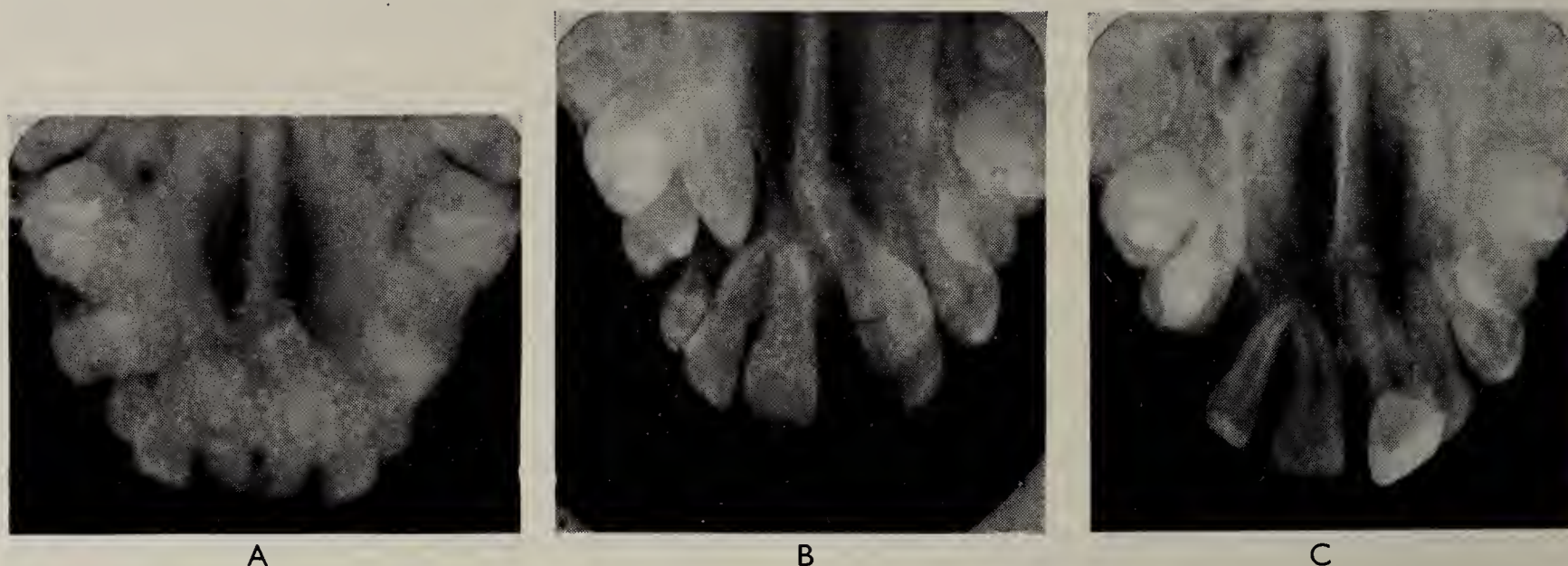


Fig. 1.—Case 1. Multiple supernumeraries. A, Preoperative X-ray. B, Twenty months later; before second operation. C, Five months after capping.

continuously variable series from the simple to the complex. As a result of this, and in order to be able to describe these teeth, it has been necessary to classify them broadly into four classes based upon their morphology.

The morphological features of the supernumeraries that have been regarded as important in this study are those of size and shape.

The first and simplest type distinguished is the peg-shaped supernumerary. This is usually of small size and occurs commonly in the midline, either vertically placed or inverted. In this situation it usually causes no abnormality within the arch. It may, if occurring to one side of the midline, cause a rotation or displacement of the incisor, but only very rarely does it cause delayed eruption. No examples of this type were found in the re-operation group.

The second type that has been distinguished is the incisiform supernumerary. This is characterized, as might be supposed, by a flat, blade-like crown similar to that of an incisor; it is rather larger than the previous type. It may occur in the central incisor region, where it appears to occupy the space usually occupied by the central incisors, causing delayed eruption and displacement of the incisors. Of the 11 examples of this type found, all but 1 case occurred in the delayed eruption group and 2 cases were found in the

feature in all but two cases of the re-operation group.

Fig. 1B shows the situation 20 months later, at the time of the second operation and capping of the incisor; the $\underline{11}$ being still unerupted and displaced. *Fig. 1C* shows the situation 5 months after the second operation.

The third category of supernumeraries has been termed the invaginated group, because at the time of operation a large number of this type have a depression of greater or lesser depth at the incisal end and do occasionally bear a resemblance to the dens in dente type of odontome. They are recognized radiographically by their short, rather barrel-shaped, appearance; their width nearly equalling their length. They are usually accompanied by a marked displacement of the permanent incisors particularly the apex, and when they are paired the separation of the incisor apices is very marked.

Fifteen examples of this type of supernumerary were found, all of which were in the delayed eruption group, and 6 of these went on to further surgery.

It appears, therefore, that the invaginated supernumerary is more likely to cause delayed eruption and predisposes to the need for further surgery. It is proposed to discuss the possible reasons for this in a later section.

The final type of supernumerary distinguished is the odontome-like supernumerary. True odontomes, of course, come into this category, as

In the next X-ray, *Fig. 2B*, the situation 1 year later shows that the 2| has erupted, but the 1| has not improved in position. At this stage the 2|

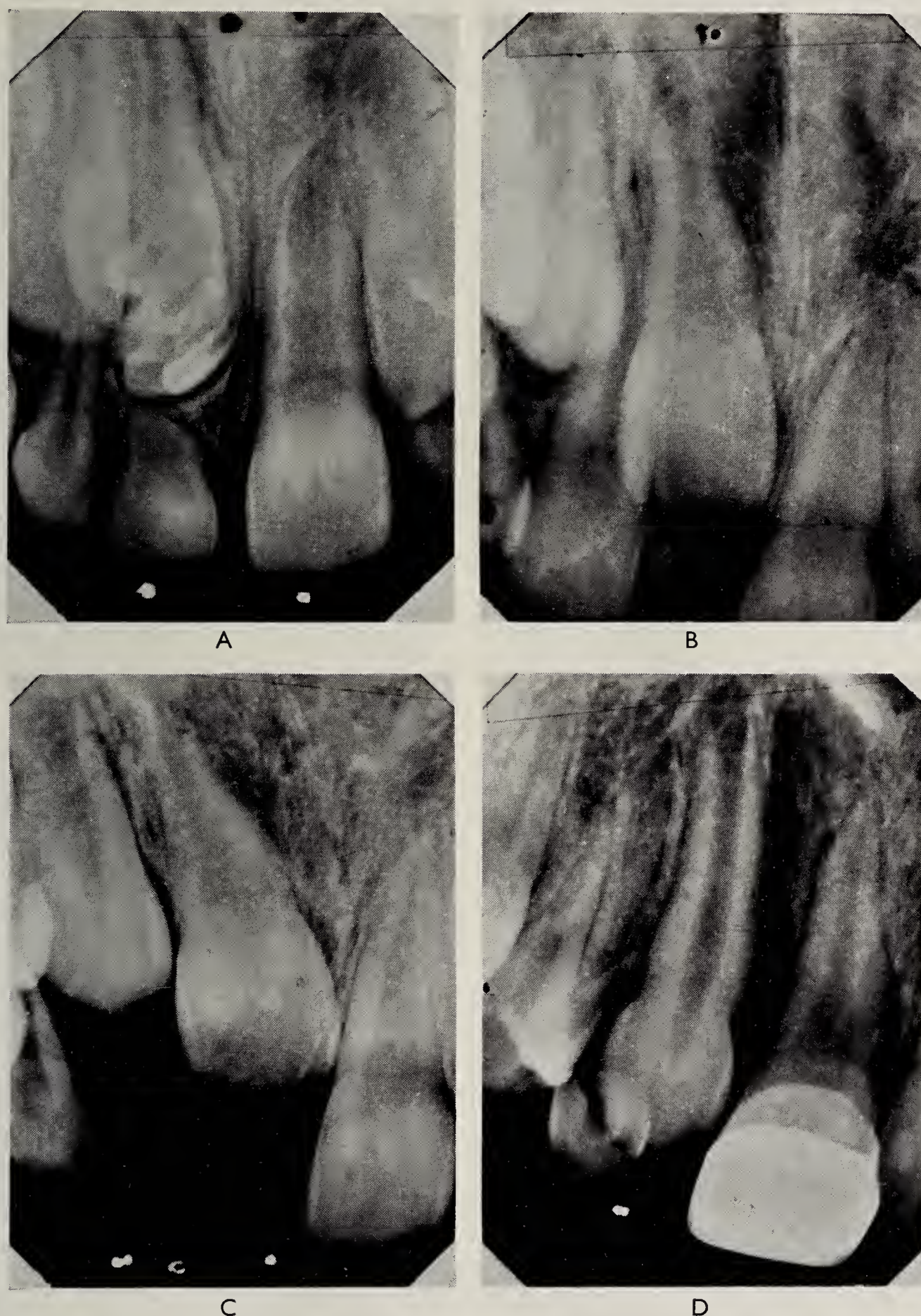


Fig. 2.—*Case 2.* Odontome-like supernumerary. A, Preoperative X-ray; note level of 2| and 1|. B, One year later, before extraction of 2| which has erupted; 1| position has not improved. C, Six months after extraction 2|, 3| appears to be contributing to increased mesio-angular inclination of 1|. D, Nine months after capping.

well as those supernumeraries whose form and bulk make them unsuitable for inclusion in the other categories.

Three supernumeraries of this type were found, of which two were in the re-operation group. *Fig. 2A* shows one of these cases preoperatively.

was extracted and the situation, largely unchanged, is seen 6 months later in *Fig. 2C*; the 3| at this stage appears to be contributing to the mesial inclination of the 1|. At this time there was a second operation in which the 1| was capped. *Fig. 2D* shows the situation 9 months later.

c. Position

To investigate the relationships between the sites of the supernumerary teeth and the underlying incisors has not proved possible throughout

necessary for each case. These conditions could not be met in each case, and it was felt that conclusions drawn from only part of the sample might be misleading.

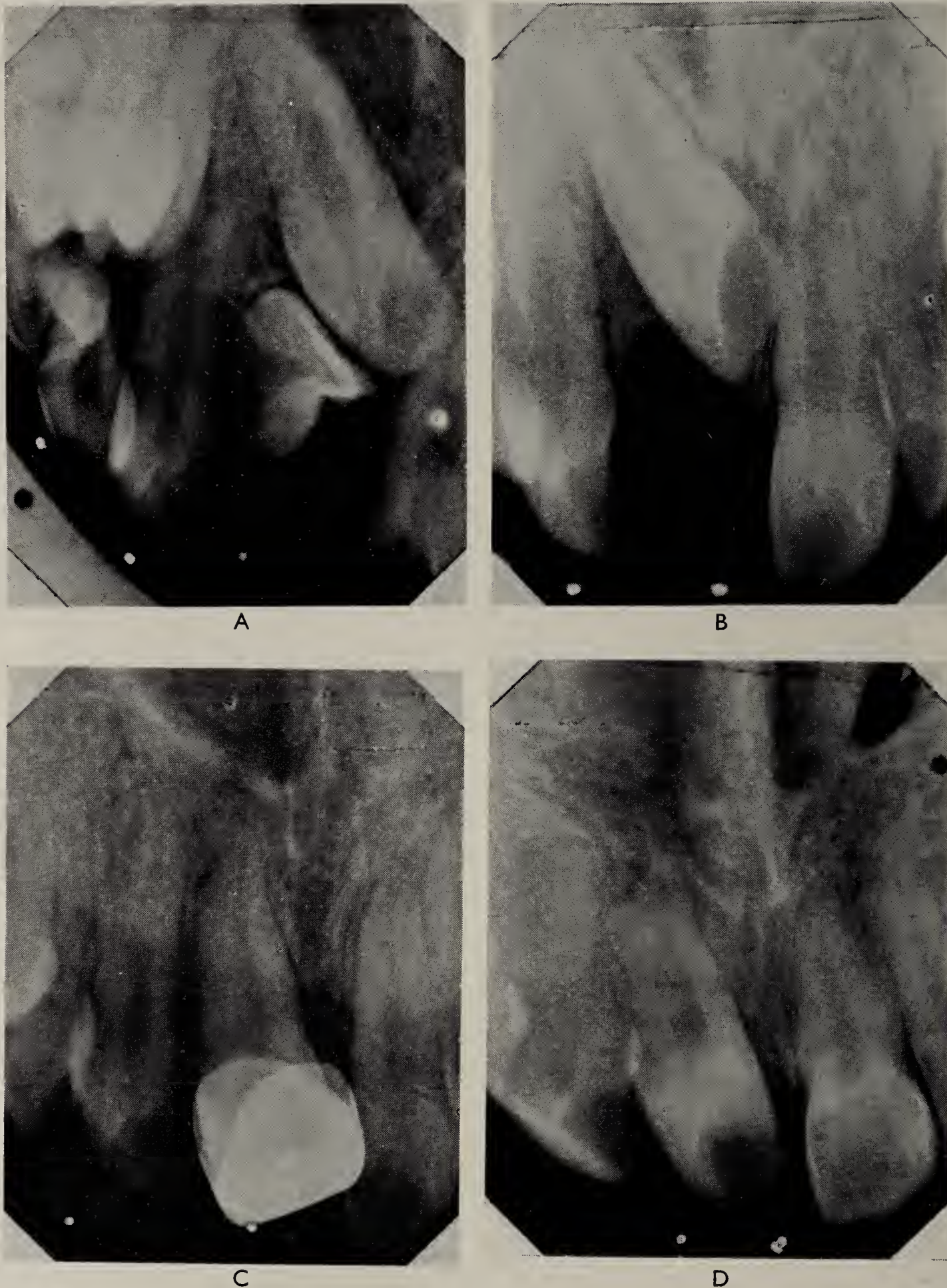


Fig. 3.—Case 3. Incisiform supernumerary. A, Preoperative X-ray; note apical displacement $\frac{1}{2}$ apex. B, One year post operatively; space adequate within arch for $\frac{1}{2}$. C, Nine months after capping. D, Six months later; slow movement to final occlusal level.

this study. A standardized X-ray technique would have been required so that strictly comparable films could have been taken and a specialized view, the vertex occlusal, would be

A condition did occur in 3 of the cases in the re-operation group, however, which related to the position of the supernumerary, and this was almost unique to this group.

The X-ray, *Fig. 3A*, shows an incisiform supernumerary present in a horizontal position in the region of 11. The crown of 11 is displaced mesially and is rotated through 90°; the apex

arch for 11. A further 6 months elapsed with little change, and a further surgical episode followed in which the tooth was capped. *Fig. 3C* shows the situation 9 months after capping and *Fig. 3D*

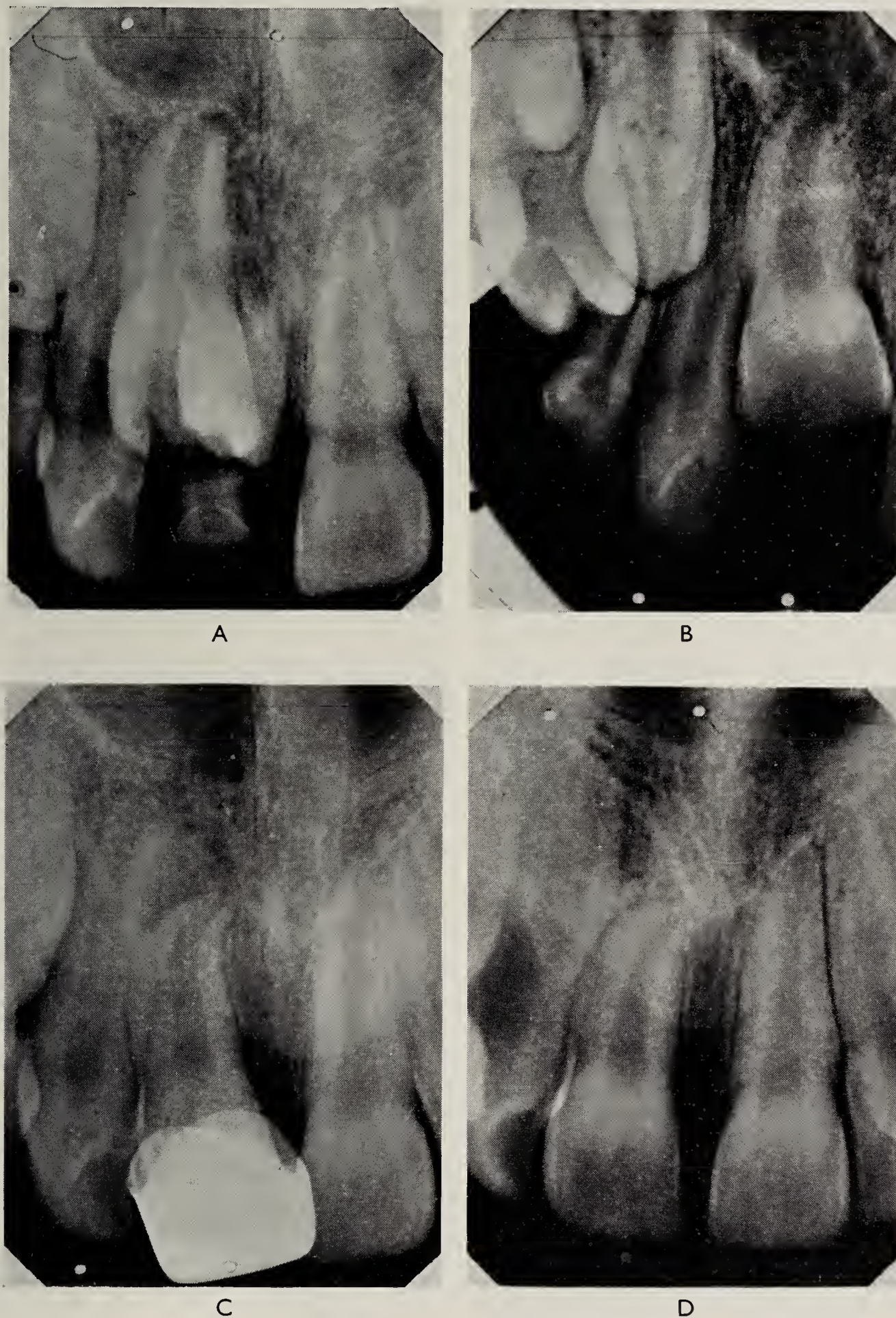


Fig. 4.—Case 4. Invaginated supernumerary. A, Preoperative X-ray; note space between crown of 11 and root of 11. B, One year later 11 crown now appears to be in close apposition to 11 root. C, Four months after capping. D, Six months later 11 apex complete; terminal root deformation apparent.

being markedly displaced in a distal direction. One year later the situation was as in *Fig. 3B*, with no change in the position of 11; it will be noticed that sufficient space exists within the

after a further 6 months, illustrating the deceleration of the rate of eruption.

Three further cases of this type are represented in the series, but since they were only operated

on recently and were treated in a different manner at operation, they have not been compared with these cases.

3. Factors Relating to the Incisor Teeth

a. Apical Displacement

Displacement of the crowns of the incisor teeth was a common feature of the majority of the cases in the delayed eruption group, and consisted usually of a simple labial or lingual displacement. The amount of mesial or distal displacement was small and the displacement of the apices minimal or nil.

A feature of 8 of the 10 cases in the re-operation group was a marked displacement of the apex and a rotation of the tooth around its transverse axis. In 6 of these cases the displacement of the apex was in a distal direction and of such a degree as to cause the crown to form a frankly mesio-angular impaction with the other central incisor. In the other 2 cases of apical displacement both had their apices displaced mesially, but the distal position of the crown was labial in 1 case and palatal in the other. Apical displacement more than any other factor seems to have distinguished the re-operation group.

b. Root Morphology

In only one case did the shape of the root appear to be an important factor and this case occurred in the re-operation group.

The preoperative X-ray, *Fig. 4A*, shows an invaginated supernumerary in association with 1; a clear space exists between the crown of 1 and the root of 1 at this stage. The supernumerary was removed, and, on re-X-ray one year later, there appeared to be contact between the crown of 1 and the root of 1 (*Fig. 4B*). The tooth was exposed and capped at this stage, under local anaesthesia, and the next X-ray, *Fig. 4C*, shows the situation 4 months later. After a further 6 months the tooth was in a satisfactory position (*Fig. 4D*).

It appears that after removal of the supernumerary the central incisor merely attempted to erupt along the axis of its root which, since it was curved, brought it into a mesio-angular relationship with the other central incisor.

CONCLUSIONS

One of the few distinguishing features of the group requiring re-operation was the amount of apical displacement that was present. For a tooth to fail to erupt after the removal of the supernumerary tooth and after the creation of sufficient space, it appears that a degree of impaction must exist. This may be a soft tissue impaction occurring above the level of the mucosal reflection, or, much more commonly, an impaction against the other central incisor. This may be caused by the presence of multiple super-

numeraries, particularly if their form and size is such that they cause an upward and distal displacement of the apices of the developing incisors.

Single supernumeraries may produce the same distal displacement of incisor apices, especially if they are of a size or position to occupy the major portion of the alveolus in the buccolingual dimension occlusal to the unerupted incisor.

In some cases the root morphology may be such that it tends to produce a deflected path of eruption leading to such an impaction.

Treatment of the Unerupted Incisor

Many methods have been described for the treatment of unerupted incisors, but perhaps the most time-honoured and widely used is that of exposure and packing. After a suitable opening has been made in the bone and mucoperiosteum to enable access to the incisor to be gained, a pack is inserted to maintain this opening and may at a later stage be supplanted by an acrylic bung. This method is simple and needs no special materials, but does require regular attendances to enable the pack to be changed or the bung to be trimmed. In some cases, especially those in which the incisor is deeply placed within the alveolus or above the level of the mucosal reflection, it may prove impossible to obtain in the first instance a wide enough opening to maintain its patency throughout the period of eruption. Little measure of control can be exercised over the path of eruption of the tooth, even when exposure is adequate.

The majority of the other methods that have been devised have had as their aim the elimination of the two disadvantages of the packing method, namely, the pack itself, which is required to keep the wound open, and the lack of control over the erupting incisor. Day (1946) has described the use of a wire loop which is inserted into a prepared cavity in the incisor and Kettle (1958) has described a technique of pinning incisors similar to that technique successfully used for impacted canine teeth. Hotz (1961) has described a method that requires the drilling of a hole completely through the crown of the incisor to accommodate a wire sling. Other methods of banding and crowning are numerous, and many of these require the taking of an impression so that a metal casting or acrylic crown can be fabricated, thus turning the procedure into a two-stage operation.

The author's excuse for submitting yet another method of treatment is that this technique is rather simpler than the majority of those already described. It obviates the need for packing and offers some degree of control over the erupting incisor. It also has the advantage over many techniques in that no cavity preparation is required; it is a one-stage operation.

TECHNIQUE

This technique utilizes the pre-formed stainless-steel crown forms made in a range of sizes and intended as temporary crowns for prepared or fractured incisors (*Fig. 5A*).

Preoperative Preparation

A crown form of suitable size is selected, using the erupted incisor as a guide; an easy fit rather than a tight one is desirable. The labial and

exists to enable the crown form to be fitted over the crown of the tooth and internal to its follicle. The bone removal may be quite minimal in the case of a labially displaced incisor, or may be more extensive, perhaps a third to a half of the crown length, in a more unfavourably situated tooth.

When proper seating of the crown form has been obtained, the area is dried and the crown form cemented with white oxyphosphate cement (*Fig. 6C*). Overfilling of the crown form with

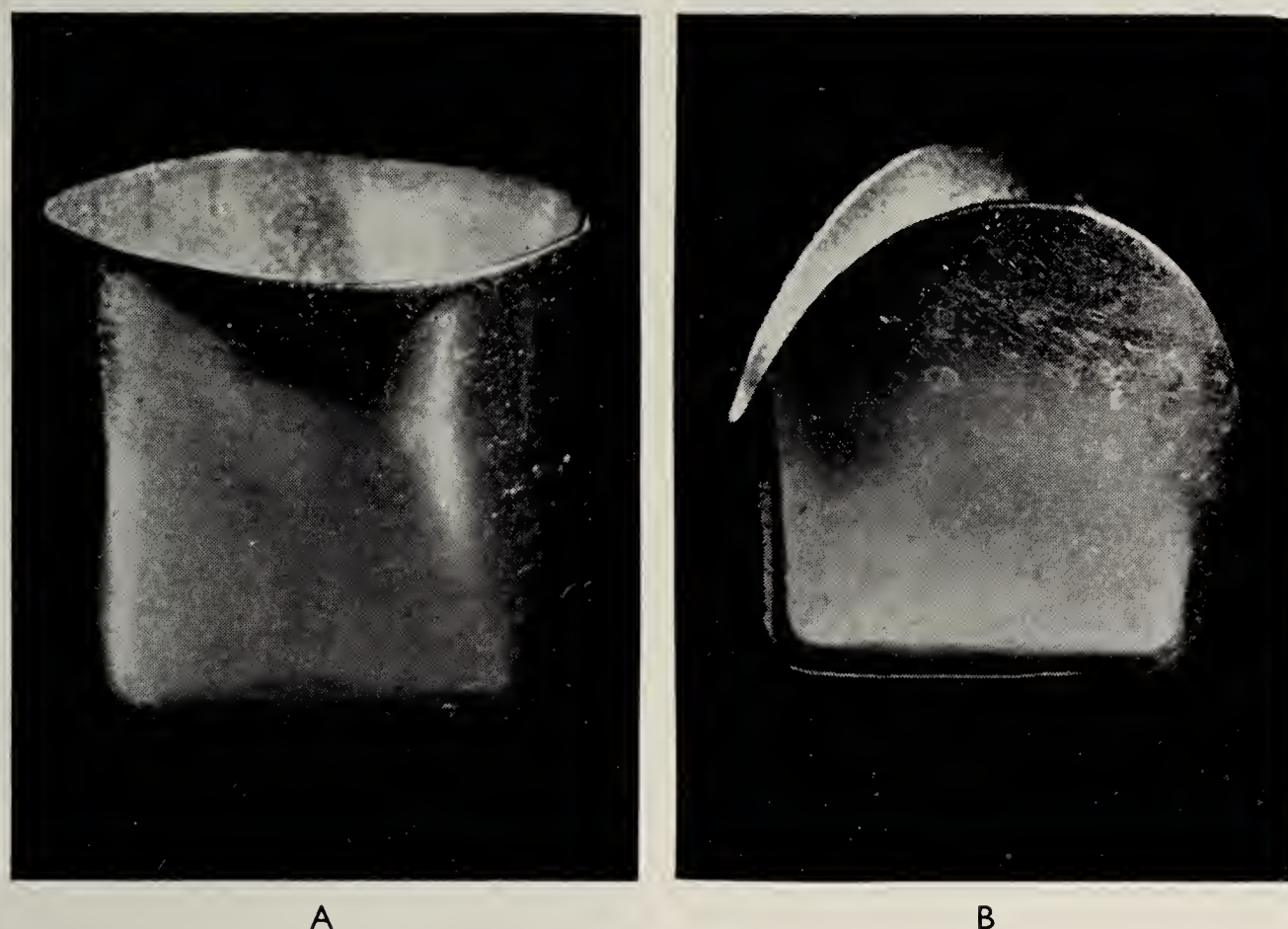


Fig. 5.—Stainless-steel crown form. A, Before trimming. B, After trimming.

palatal aspects of the crown form are then trimmed with stones so that they approximate to the amelocemental contour, but are 2–3 mm. short of this. Mesially and distally the trimming is exaggerated and approaches to within 3–4 mm. of the incisal edge (*Fig. 5B*).

This enables the crown form to be manipulated more easily into position in those cases already described where there is a mesio-angular impaction of the incisor. When trimming is complete the margins are bevelled to a knife-edge. A stainless-steel orthodontic staple is then welded on to the crown form either palatally, in the case of a tooth labially displaced, or labially on a tooth palatally displaced.

Operation

Under local or general anaesthesia a muco-periosteal flap, usually a labial one, is reflected and bone removed with burs until the unerupted incisor is identified and its angle of inclination determined (*Figs. 6A, B*). Further bone removal then takes place incisally until sufficient space

cement should be avoided as removal of excess cement from the cervical area of the unerupted tooth may be difficult. It may also prevent full seating of the crown form on to the tooth.

In the badly displaced tooth where some guidance during eruption is required a 0.25 mm. soft stainless-steel wire loop engaging the staple may be required. The wound may then be closed completely, leaving the wire ligature depending from the suture line (*Fig. 6D*); this may be engaged by a spring from an appliance at a later date (*Fig. 6E*). If the tooth is more superficial a small part of the flap margin may be removed, leaving the most prominent part of the crown form exposed. There seems little tendency for this to close postoperatively.

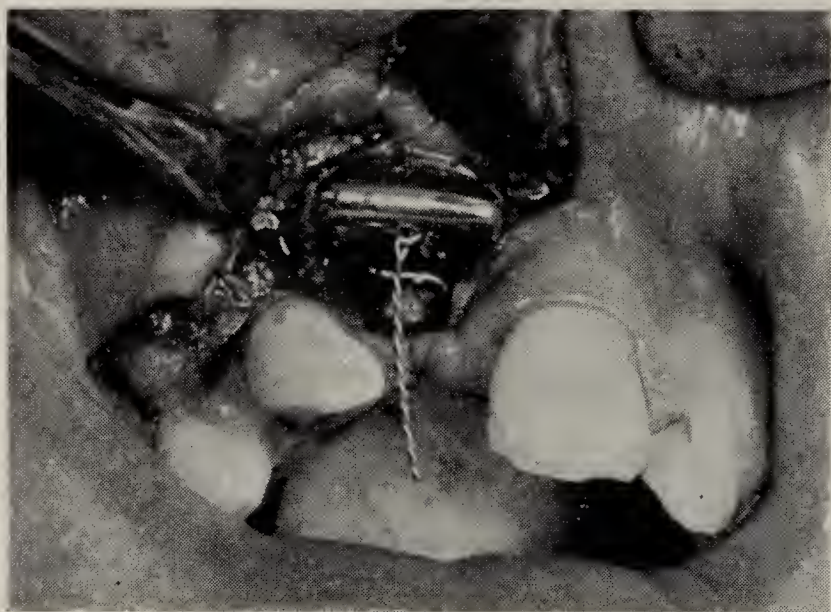
The crown forms are well tolerated by the tissues and no untoward reaction has been experienced. It has been customary to apply no force to the capped incisor for one month postoperatively. Eruption is usually quite rapid, and when the incisor is nearly to the correct occlusal level



A



B



C



D

Fig. 6.—Capping procedure. A, Preoperative photograph: space has been lost in I region. B, Buccal mucoperiosteal flap reflected and bone removed with burs to expose incisal edge of I crown. C, Stainless-steel crown cemented in position and wire ligature attached to palatal staple. D, Wire ligature passing through incision after suturing. E, Two months postoperatively; the I has erupted and gentle traction is applied to correct axial inclination I.



E

the crown form may be removed with anterior band removing pliers.

Six of the re-operation group were treated in this manner and a further 12 cases exhibiting delayed eruption for various reasons have been treated using the same method. Some of these cases had features discussed earlier in this paper that appeared to predispose to a complicated postoperative history, and it is hoped that it will be possible to see at a later date if the need

for further surgery has been avoided using this method.

(An 8 mm. cine film of the capping procedure was then shown.)

Acknowledgements

My thanks are due to Mr. Leighton and to Mr. Kettle for their encouragement and indulgence in the preparation of this paper; to Mr. Watson for the cine-photography and to Mr. Smith for

the still photographs. I would like to thank also those colleagues and practitioners who very kindly sent me X-rays or case histories of those cases that have passed into their care.

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DISCUSSION

Mr. E. S. Broadway said that so far as supernumerary teeth were concerned the priorities in getting the central incisor down were, first, the time of the diagnosis, secondly, who did the operation and, thirdly, was there enough space for it? He was a little horrified by the complications of treatment demonstrated by Mr. Howard because, in his experience, if one simply removed the supernumerary, doing the very minimum of surgery, then one got the minimum of fibrosis and the tooth erupted provided there was enough space. As Mr. Hovell's one-time senior registrar he was surprised that Mr. Howard stated that Mr. Hovell advocated the exposure of the crown of the incisor, for this was something he had strongly condemned for the past ten years.

There was one other question; if an early diagnosis was made, how early should the supernumerary tooth be removed? He showed a slide of a patient of 18 months old, with an erupted supernumerary present in the deciduous dentition and also the forming crown of a supernumerary tooth in the permanent dentition. He wondered whether Mr. Howard had seen anything like it, and when he would advocate removing the permanent supernumerary tooth?

Mr. R. T. Broadway contended that the main reason for not exposing the crown of the unerupted tooth was that, providing enough room was made for the tooth, it came down in the bone, and if it did not erupt it came down so far that surgical exposure involved a very minimum of bone removed. If one proceeded earlier and removed a large amount of bone it was found that the tooth never came down quite to the occlusal level of the remaining incisors and the cervical margin was always a little higher than that of the other incisors. Secondly, he could not understand why the wound was stitched up after the crowning; he could understand stitching the edges, but why stitch it right up all the way along?

Mr. Howard said that he was very relieved and glad that they (the Broadways) were not triplets!

The first point, which came from Mr. E. S. Broadway, was on the matter of complicated surgery, but in his view this was in fact simple and he could justify it. The normal process of eruption involved at some stage or other the fusion of the follicle of the tooth with the epithelium of the oral mucosa. This happened as a normal sequence of events. By removing the bone from the incisal edge of the unerupted incisor, one got inevitably a reformation of the follicle around the incisor, and this was nearer the oral epithelium because of the bone removal. If fusion of the follicle and the oral epithelium then took place, earlier eruption resulted.

As to the matter of fibrosis causing delayed eruption, this was a little difficult, because in the first few cases

the tissue from the occlusal aspect of the unerupted incisor was sent for histological section and was reported back as normal tissue. There was no clinical evidence of the fibrosis and scar tissue that had been talked about and he had not seen any evidence of it himself; it appeared to be just normal tissue, not scar tissue.

As regards the other point, Mr. Howard was quoting from a paper of Mr. Hovell, who advocated three criteria to ensure the eruption of the unerupted tooth, namely: (1) That the supernumerary tooth must be removed; (2) That the crown must be exposed; and (3) That sufficient space for the unerupted tooth was required within the arch. He thought that there could be some discussion of the second point.

He agreed that after exposure of the incisor crown the gingival margin was at a higher level for a time, but in his experience this condition disappeared as the remaining incisors erupted further.

Commenting on the best time to remove the supernumerary tooth, he thought this was in the tenth year. This was perhaps enforced at King's due to the difficulty of obtaining children's beds under this age. This did seem a better time, rather than earlier, when there was a danger of dislodging the unerupted incisor. At a later stage there was the risk of loss of eruptive potential in the unerupted tooth.

Mr. J. S. Beresford said that when he referred patients for the removal of supernumerary teeth he asked the oral surgeon also to remove the deciduous canines if there had been any loss of space for an unerupted incisor. At the same time, he thought it prudent to impress upon the parent that, in due course, permanent teeth might have to be sacrificed, because otherwise they might think that the object in extracting the premolars later was to cover up some earlier error. He would not be inclined to ask for a second operation unless orthodontic appliances had provided more than sufficient space for the unerupted tooth.

Mr. A. J. Walpole Day said that there were two points on which he would like Mr. Howard to comment. First, he had been to some trouble to establish the causes which made a second operation necessary, including an analysis of the different types of supernumerary teeth. There was, however, one factor concerning these which had not been mentioned namely that the two main types of unerupted supernumerary teeth, the haplodont and the tuberculated, developed at different ages. The simple haplodont tooth formed early and had a small conical crown and complete root, whereas the tuberculated variety formed after the permanent incisor and was usually represented by a crown and partly-formed root. It was situated between the

deciduous and permanent incisor and prevented the permanent tooth from erupting. All the cases shown were of the latter type.

The second point concerned the paper he himself had written on this subject about which his ideas had now changed. For the past twenty years rings had not been inserted into the crowns of unerupted teeth. The procedure now was to expose the whole of the palatal aspect of the unerupted tooth, after removing the supernumerary, and put in a pack of zinc oxide and oil of cloves on cotton-wool. The pack was left in situ for at least 4 weeks. After 8 weeks the tooth had usually erupted and the need for a second operation was avoided. He did not do the surgery himself, but left it to his more expert colleagues after carefully discussing the details.

Mr. Howard said he had not seen a single example of the simple, complete type involved in the non-

eruption of teeth in this series. The supernumeraries causing delayed eruption and illustrated were all incomplete as regards root formation. Speaking from memory, he thought that there might be some evidence, too, with regard to the site of development which appeared to go hand-in-hand with the state of development. The farther from the midline the more incomplete the development appeared to be, and he did not think this had been noted before.

As to the technique of exposure and packing, this was of course the traditional method of treatment, but he still thought that this was inconvenient. It was easier to cap the incisor and forget about packing; the tooth usually erupted quite quickly after 4 to 6 months, also the packing method could not be carried out satisfactorily when the unerupted incisor was situated at a level above the reflection of the mucosa in the labial sulcus.

CLASS II TREATMENT— TWO CASE REPORTS

J. METCALF, L.D.S., D.Orth. R.C.S.

Senior Registrar in Orthodontics, Guy's Hospital

THE object of this communication is to present the case histories and treatment relating to two patients with Class II, division 1 malocclusions. They have very different morphological features and there has been a different approach to treatment. Neither case has been out of retention for sufficient time to make a final assessment, but the incisor relationship is considered to be relatively stable.

CASE REPORTS

Case 1 (D.L.) (Figs. 1-4)

This patient first presented at the age of 8 years, 7 months with a severe Class II, division 1 malocclusion on a Skeletal II base. This is illustrated by the lateral skull tracing (Fig. 2A).

The lips were classed as potentially competent. Although the lower lip was tightly indrawn behind the upper incisal edge during swallowing and expres-

She returned at the age of 11 years, 9 months and a re-assessment was made (Fig. 1B). At this time the incisor overjet was 12 mm. The upper arch was well developed with the premolars erupted, but $\overline{5|5}$ were lingually displaced. A complete overbite was present.



A



B



C

Fig. 1.—Case 1. Full-face and profile photographs at A, 8 years; B, 11 years; C, 14 years.

sive movements, it was considered that it would be possible to retract the upper incisors to a position within lower lip control and this should result in a stable position of the upper labial segment.

It was decided to commence treatment early in this case by extracting $\underline{C|C}$ and fitting a monobloc. This unusual procedure was planned because it was doubtful whether the patient could obtain adequate supervision in Aden, where she was going for some time. This was later to be followed by upper premolar extractions and removable appliance therapy. The child went abroad for 3 years and did not wear the appliance.

The lateral skull tracing (Fig. 2B) showed:—

SNA 82°	$\frac{I I}{\text{max. plane}}$ 127°
SNB 73°	$\frac{I I}{\text{mand. plane}}$ 89°
Diff. 9°	Max. mand. plane \angle 31°

TREATMENT

This was commenced with the extraction of $\underline{4|4}$ and the fitting of an upper removable appliance to retract $\underline{3|3}$, using a bite plane to reduce the depth of overbite and reinforce the anchorage.

When this was achieved, retraction of $\underline{2|12}$ was commenced, but the anchorage began to slip and was reinforced with extra-oral traction. A simple cervical

Presented at the meeting held on 9 January, 1967.

strap was used, the traction being applied to 'whiskers' soldered to a labial bow. This fitted into tubes soldered to the Adams' cribs on upper appliance.

buccal segments achieved with the extra-oral traction. The upper incisors were retracted to a position of contact with $\overline{21|12}$, and within lower lip control.

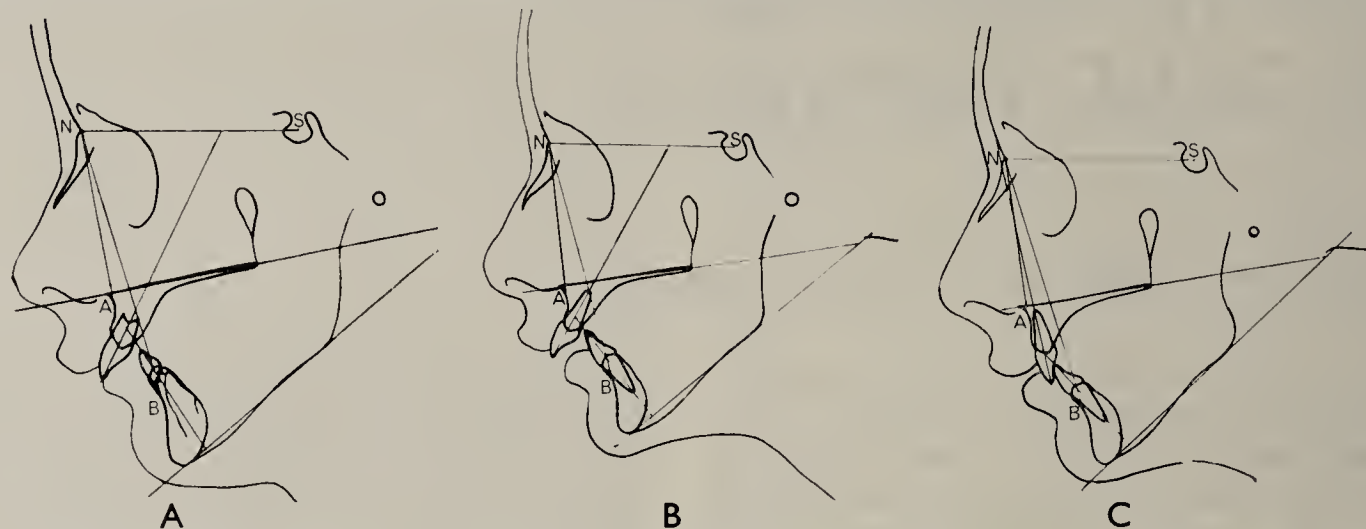
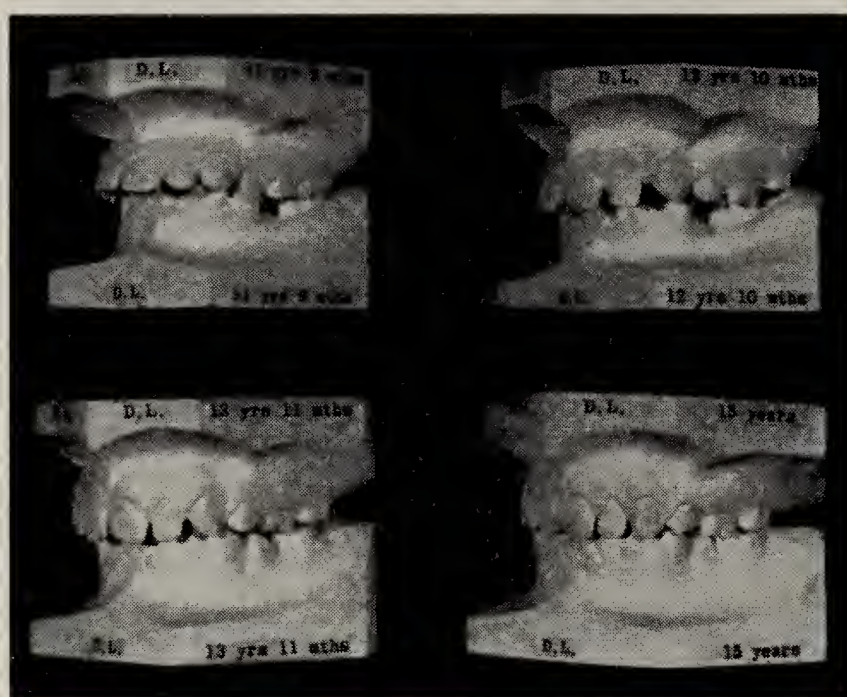
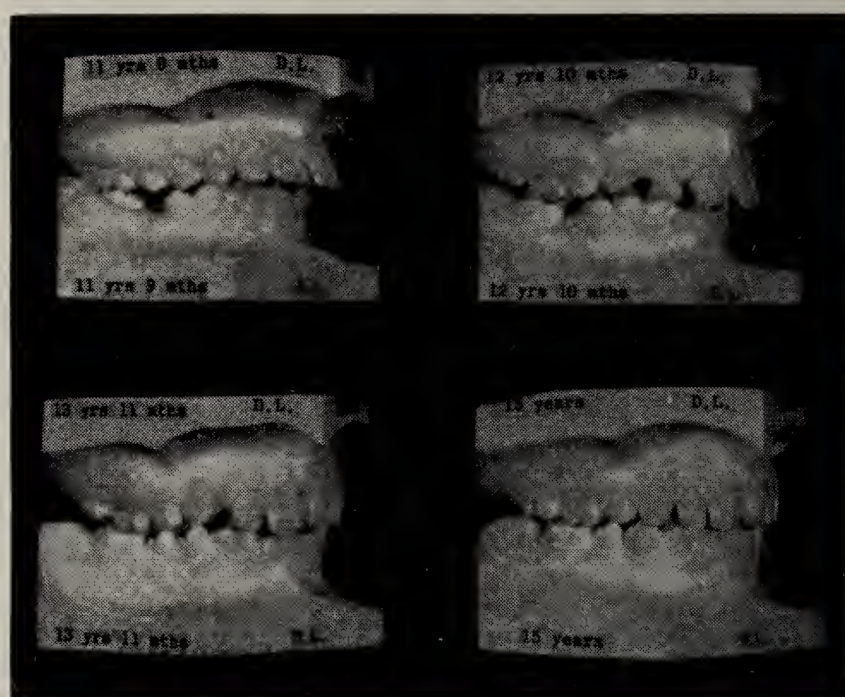


Fig. 2.—Case 1. Lateral skull tracings at A, 8 years; B, 11 years; C, 14 years.



A



B

Fig. 3.—Case 1. Models. A, Left side; B, Right side.

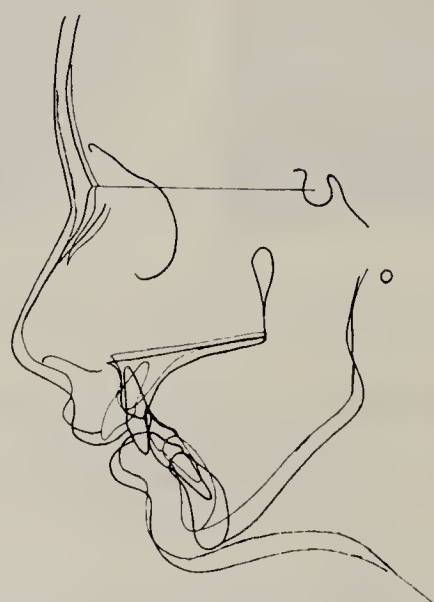


Fig. 4.—Case 1. Superimposed tracings at 11 years and 14 years.

In the lower arch $\overline{7|7}$ were extracted and a bilateral screw plate fitted to move $\overline{6|6}$ distally. $\overline{5|5}$ were then moved into the arch.

The retraction of the upper incisors was meanwhile continued and slight distal movement of the upper

A lateral skull tracing (Fig. 2C) at the completion of appliance therapy and four months retention showed:—

SNA 81°	$\overline{1 1}$ to max. plane 86°
SNB 72°	$\overline{1 1}$ to mand. plane 90°
Diff. 9°	Max. mand. plane $\angle 34^\circ$

Discussion

It is open to question as to whether it is correct to overretract $\overline{21|12}$ and allow the apices to move labially as in this case. Many American orthodontists would disagree with this 'rabbitting' back of $\overline{21|12}$ and favour a fixed appliance to move the apices of $\overline{21|12}$, or early cervical traction to influence the A point position.

Pringle (1955), Ballard (1957), Tulley and Campbell (1966), and Orton (1966) have suggested that in many of these cases with a severe overjet, the upper incisors have to be retracted so that the lower lip cannot get beneath them. This will necessitate this overretraction in Skeletal II cases.

There is no untoward flattening of the profile of this patient (*Fig. 1*), but there is no doubt that there is a limit to the extent to which these cases should be treated with removable appliances.

The superimposed tracings (*Fig. 4*) show that very little growth has taken place over the period of treatment.

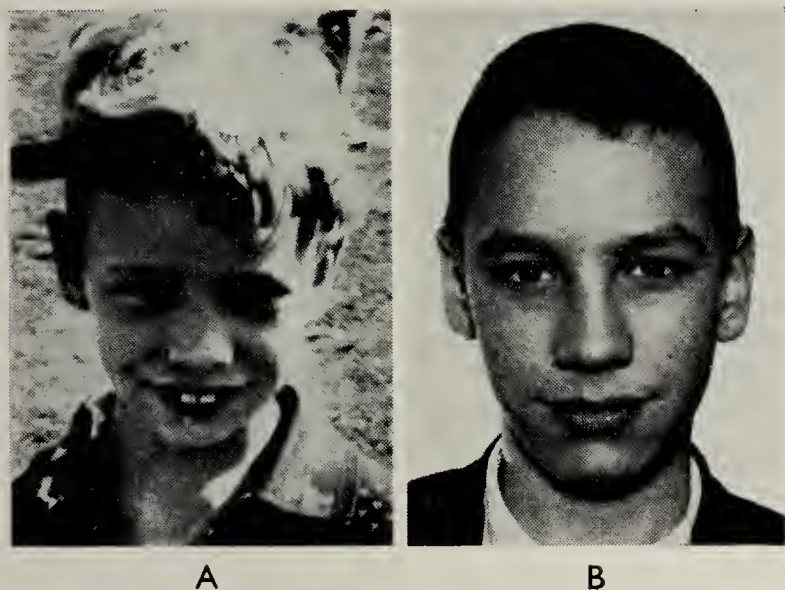


Fig. 5.—Case 2. Photographs at A, an early age; B, 14 years.

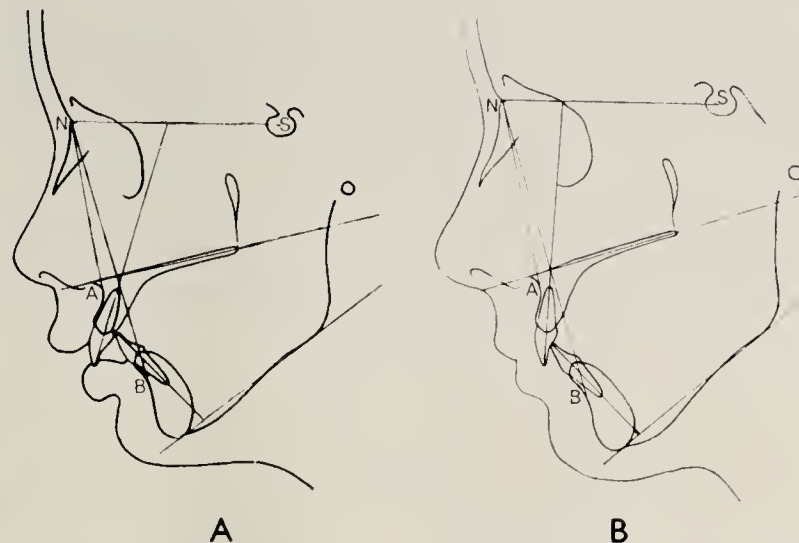
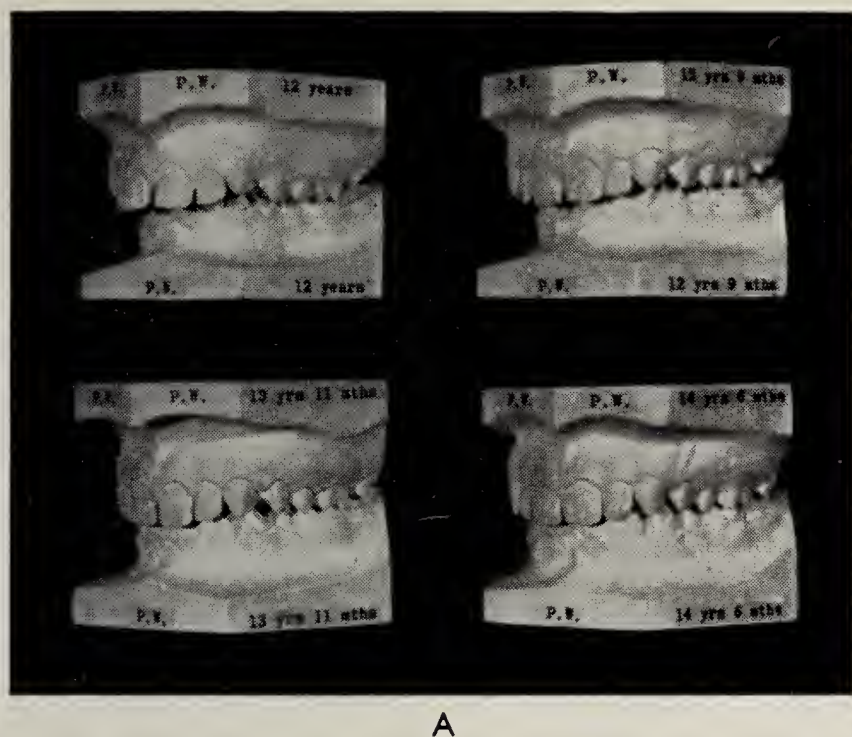
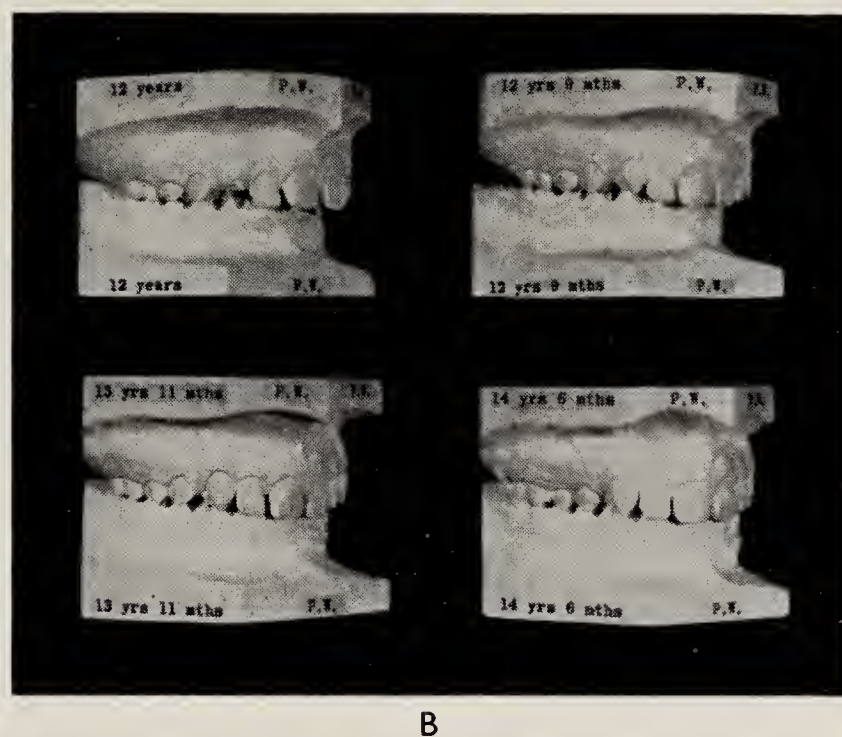


Fig. 6.—Case 2. Lateral skull tracings at A, 12 years; B, 14 years.



A



B

Fig. 7.—Case 2. Models. A, Left side; B, Right side.

It was decided to extract $\overline{7|7}$ in this case because there was crowding bilaterally in the premolar region in the lower arch. However, in retrospect, extraction of $\overline{4|4}$ would have been better and prevented the slightly outstanding $\overline{4}$ and would not have impaired the position of the lower labial segment. Extraction of $\overline{5|5}$ might have given a poor contact between $\overline{4|4}$ and $\overline{6|6}$. $\overline{6|6}$ were sound teeth and lateral oblique radiographs showed $\overline{8|8}$ unerupted and developing very short of space.

Case 2 (P.W.) (*Figs. 5–8*)

This patient presented at the age of 12 years, 2 months. A mild Skeletal II relationship was present and confirmed by a lateral skull tracing (*Fig. 6A*)

assessed by Downs (1948) and Ballard's (1948) methods.

The Class II, division 1 malocclusion was severe with a 12-mm. overjet and a complete, very deep overbite. The upper premolars were in complete buccal occlusion to the lower premolars. The lips were confirmed as being incompetent, and the lower lip was completely tucked behind $\overline{1|1}$ during swallowing and expressive behaviour.

It was unfortunate that the only original photographic record was poor, and that no profile picture was available (*Fig. 5A*). But this suitably illustrates the appearance and overjet at an early age. The initial lateral skull tracing (*Fig. 6A*) showed:—

SNA 78°	$\overline{1 1}$ to max. plane 120°
SNB 73°	$\overline{1 1}$ to mand. plane 99°
Diff. 5°	Max. mand. plane $\angle 23.5^\circ$

TREATMENT

A monobloc was fitted and trimmed, but the patient was not very co-operative and the appliance was not worn consistently. In the first 9 months of treatment very little progress was made (*Fig. 7*). Later a new monobloc was constructed with buccal arms to bring $\overline{54|45}$ into the arch and correct the occlusion. A

marked improvement took place, probably associated with complete co-operation in wearing the appliance, and in 5 months the correction was almost complete.

A lateral skull tracing (Fig. 6B) at this stage showed:—

SNA 77°	$\frac{1}{1}$ to max. plane 111°
SNB 73°	$\frac{1}{1}$ to mand. plane 95°
Diff. 4°	Max. mand. plane \angle 23°

Discussion

There was no adverse effect on the lower arch. It was interesting to note that instead of proclining the lower incisors the axial inclination

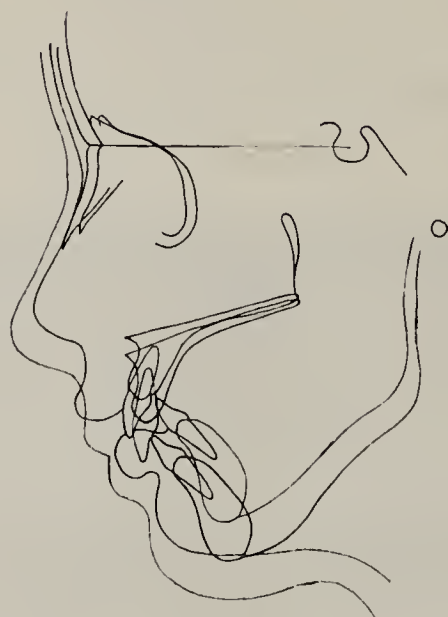


Fig. 8.—Case 2. Superimposed tracings at 12 years and 14 years.

decreased by 4°. The accuracy of fit of the appliance in the lower arch, including the lingual sulcus, is essential and can gain sufficient anchorage for considerable traction to the upper arch as

DISCUSSION

The President asked Mr. Metcalf to say a little more clearly why he had chosen the Andresen for the second case as opposed to the treatment given in the first case.

Mr. Metcalf said that the extraction of the upper second premolars might have been considered in this case, but it was decided to try a monobloc principally to see if growth would be favourable.

Mr. M. A. Kettle said that one fact which emerged from the paper was the difference in the growth response to orthodontic treatment. He asked whether Mr. Metcalf had made a check on the other growth centres of the body to see whether bone growth was progressing normally in both of these cases.

Mr. H. Lester asked Mr. Metcalf how, if at all, he trimmed the monobloc with respect to the lower arch.

Mr. B. S. Cryer said that he had recently had an opportunity of seeing how this type of malocclusion was treated in America. He thought that there would have been commiseration for Mr. Metcalf over the first case because it was difficult. With such a severe Class II skeletal pattern the major improvement in facial aesthetics could only come from good mandibular growth, which was not forthcoming in this case.

long as the acrylic extends over the incisal edges of $\overline{21|12}$. Providing good arches are present the monobloc may be used in Class II cases seen with a buccal occlusion of the cheek teeth, using buccal arms and trimming the acrylic clear on the palatal side whilst still exerting some distal force (Rix, 1966). No attempt was made to increase the width of the lower arch as the buccal segments were not lingually inclined.

This rapid improvement may possibly be attributed to the patient's sudden full co-operation which previously had not been obtained.

Certainly, in this case, considerable growth took place during the period of treatment compared with the previous case (Fig. 8).

Acknowledgements

Thanks are due to Professor Tulley for permission to show these cases under his care, and for his help in the preparation of this paper; also to Mrs. Rawlins for the tracings, Mr. Hurt and the Dental Photographic Department, Guy's Dental School, for the photographs and, Mrs. Budge and Miss Luff for the secretarial assistance.

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There were some he had met in the United States who would have suggested a bone-graft to the chin.

As for the orthodontic treatment in this particular case he thought that in America most would have advised the extraction of four first premolars and a full-banded technique. Among the advantages would be the possibility of Class II traction to assist the apical movement of the upper incisors necessary to obtain a more ideal angulation of these teeth. In addition, there would be less tendency to increase the Frankfurt-mandibular-plane angle during reduction of the initial deep incisor overbite than with the bite plate that was used. Although the angle was only increased a few degrees this had the effect of rotating the mandible downwards and backwards and so aggravating the Class II skeletal relationship.

Mr. F. Allan referred to the use of lateral skull radiographs, and said that he had been to the Orthodontic Conference in New York last year, where one man had shown case after case of the same type, and all the views showed SNA angles of 80–82°—with a difference of 2° between SNA and SNB after treatment. He was clever enough not to show what he started with, except by models, which were like Mr.

Metcalf's. In all cases Mr. Metcalf had shown, the differences between angles SNA and SNB at the end of treatment were 4° or 5°, and yet the lower incisors hit the cingula of the upper anterior teeth. Somewhere there was a discrepancy. He thought that to some extent the skeletal pattern should alter with treatment, and with SNB coming forward, the difference should be less than 4° or 5°. Otherwise all the movement had taken place through tilting the incisors, and it would seem that they were in an unstable position.

Professor W. J. Tulley said that he had seen the second patient and made the treatment plan. He thought it fair to Mr. Metcalf if he also answered the question as to why this particular appliance was used. It is not often easy to be specific about the use of this appliance in an unusual type of case, particularly when hindsight shows it to be successful. However, the type of morphological details found in this patient, with good arches, were similar to those described by

Mr. Rix in his Presidential Address, and it was in this type of case that monobloc therapy often proved successful.

The most important factor was that the lower incisor angulation was not increased following treatment where the lower arch was used as anchorage, in fact it was reduced by about 5°. In this particular case there was certainly good mandibular growth.

Mr. Metcalf, replying to Mr. Kettle, said that he had not checked any other growth centres in these cases at all.

Replying to Mr. Lester, he said that the monobloc was trimmed occlusally to allow the lower molars to erupt, but acrylic was maintained over the lower incisors.

In reply to Mr. Allan, he said that the tracings were carried out as accurately as possible under his supervision. He could only quote the figures as being as precise as possible from the films available. He could see no adverse change in the lower incisor inclination.

A CEPHALOMETRIC ANALYSIS OF ANGLE CLASS II, DIVISION 2 MALOCCLUSION IN THE MIXED DENTITION

W. J. B. HOUSTON, B.D.S., F.D.S. R.C.S. (Edin.), D.Orth. R.C.S. (Eng.)

Senior Lecturer in Orthodontics, Royal Dental Hospital of London School of Dental Surgery

COMPARATIVELY few cephalometric studies have been devoted to the craniofacial morphology of Angle's Class II, division 2—possibly because of the difficulty of obtaining a sufficient number of cases.

Angle maintained that all distocclusions were basically similar and that Class II, division 1 differed from Class II, division 2 principally in the position of the upper incisors. This approach seems to have been widely accepted, and many cephalometric investigations into the facial morphology of distocclusion do not differentiate between the divisions.

Blair (1954) compared groups of Angle's Class I (40 cases), Angle's Class II, division 1 (40 cases), and Angle's Class II, division 2 (20 cases). He was able to demonstrate only minor differences between his Class I and Class II, division 1 groups, while Class II, division 2 differed from both in respect of a more acute gonial angle and a decreased effective mandibular length.

Ballard (1956) reported on 50 untreated Class II, division 2 cases compared with 250 randomly selected cases. The cranial base angle was the same in both groups and the maxillary-mandibular plane angle was significantly smaller in the Class II, division 2 group.

Wallis (1963) presented a fairly extensive study of 81 Class II, division 2 cases. He found significant differences in cranial base (overall length and cranial base angle were greater in Class II groups) and in several mandibular dimensions (notably the smaller gonial angle in Class II, division 2). His Class II, division 2 group was older than either control group and although a subsample was used, this was small (18 cases).

The present paper attempts to compare the craniofacial pattern of an Angle's Class II, division 2 group with those of neutroclusion and Angle's Class II, division 1 groups. This study is complementary to those of Hopkin (1961) and

James (1963) in that the method used is the same and cases reported in these studies are used as controls. The cranial base measurements were of particular interest as these studies supported the findings of Björk (1947, 1955), who suggested that this area is of importance in the determination of skeletal pattern.

MATERIALS AND METHODS

Lateral skull radiographs of 100 untreated patients diagnosed clinically as having Angle's Class II, division 2 malocclusions were randomly selected from the files of the Orthodontic Department of Edinburgh Dental Hospital. The only criteria for choice were that the lower arch was at least one half unit distal to the upper (after allowing for any posteruptive drift of the molars) and the upper incisors were retroclined (less than 104°) relative to the maxillary plane. This was checked on the radiographs.

All subjects were in the mixed dentition, i.e., central incisors and first permanent molars were in occlusion, but second permanent molars were not.

The control groups were the neutroclusion sample (consisting of some patients with normal occlusion and some with Class I malocclusion) of Hopkin (1961) and the Class II, division 1 sample of James (1963).

To minimize age differences, all groups were reduced to 46 males and 50 females (*Table I*). For this reason, the neutroclusion and Class II, division 1 values are not exactly comparable with those published in previous papers dealing with these groups. As the Class II, division 2 group was older than the control groups, a subsample was selected with a more limited age range and matched for age (*Table I*). The numbers in these subgroups are rather small, but they were of value in determining whether differences between the main groups were likely to be due merely to age. Lateral skull

Presented at the Research Meeting held in Bristol on 13 April, 1967.

radiographs were taken under the same conditions (in a Shandon cephalostat with tube-to-film distance of 72 in. and median sagittal plane of head-to-film distance of 7.5 in.) and by the same radiographer as for the control groups.

Linear measurements were made to the nearest 0.5 mm. using a vernier gauge, and angles were measured to the nearest 0.5 degree. The mean, standard deviation, and standard error of the mean were calculated for each measurement.

Table I.—AGE-DISTRIBUTION OF GROUPS STUDIED

NUMBERS IN MAIN GROUPS						
<i>Males (46)</i>				<i>Females (50)</i>		
Age (Years)	Cl. I	Cl. II, div. 2	Cl. II, div. 1	Cl. I	Cl. II, div. 2	Cl. II, div. 1
6	1	—	—	—	—	—
7	9	1	2	—	2	2
8	4	1	7	10	3	3
9	6	5	10	8	6	13
10	3	11	10	14	15	12
11	16	10	10	11	9	12
12	3	10	3	6	11	8
13	2	6	2	1	4	—
14	2	2	2	—	—	—
MEAN AGE	10.3	11.5	10.5	10.46	11	10.56

NUMBERS IN EACH SUBGROUP		
<i>Males (20)</i>		<i>Females (29)</i>
AGE (Years)		
9	5	6
10	3	12
11	10	9
12	2	2
MEAN AGE	10.95	10.74

Films of the patients both at rest and in occlusion were available, but only those taken with teeth in occlusion were used in this study.

Measurements were made on tracings of the films, the points and tracing methods being comparable with the control groups.

The definitions of points and planes are those given by Krogman and Sassouni (1957) as being in most common use and the measurements employed (*Fig. 1*) were:—

Linear Measurements

Nasion-Sella, Sella-Articulare, Nasion-Articulare, Articulare-Gonion, Gonion-Gnathion, Articulare-Gnathion, Nasion-Anterior Nasal Spine, Anterior Nasal Spine-Gnathion.

Angular Measurements

Nasion-Sella-Articulare, Articulare-Gonion-Gnathion, Sella-Nasion-point A, Sella-Nasion-Prosthion, Sella-Nasion-point B, Sella-Nasion-Infradentale, Sella-Nasion-Pogonion.

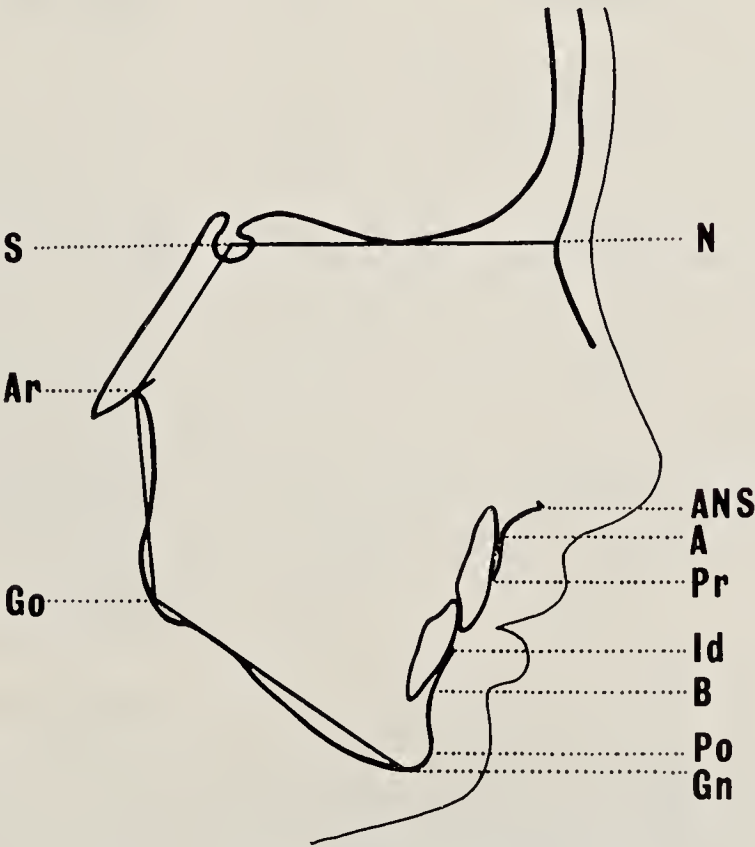


Fig. 1.—Points used in the analysis.

Overall differences between groups means were tested by an analysis of variance (Snedecor, 1956). Only if F exceeded the 5 per cent level were differences between pairs of groups tested using Student's 't' test. Significant differences are indicated in *Table II*.

Table II.—LINEAR VALUES (MM.) AND ANGULAR VALUES (DEGREES). 46 MALES; 50 FEMALES IN EACH GROUP

	SEX	NEUTROCCLUSION GROUP MEAN (\pm 1SD)	CL. II, DIV. 2 MEAN (\pm 1SD)	CL. II, DIV. 1 MEAN (\pm 1SD)	F tA tB tC
<i>Cranial Base</i>					
N-S	M.	71.48 (3.05)	73.83 (3.44)	73.34 (2.45)	** ** — **
	F.	69.19 (2.87)	71.31 (3.29)	71.48 (3.01)	** ** — **
S-Ar	M.	34.21 (4.04)	35.99 (3.51)	35.25 (2.87)	* * — —
	F.	33.20 (3.19)	34.54 (3.25)	33.85 (3.12)	NS
N-Ar	M.	95.32 (5.00)	98.94 (4.88)	98.59 (4.11)	** ** — **
	F.	91.81 (4.31)	95.61 (4.42)	96.46 (4.59)	** ** — **
\angle N-S-Ar	M.	124.34 (4.76)	125.06 (4.99)	126.77 (4.89)	* — — *
	F.	124.18 (5.18)	125.45 (4.80)	128.89 (4.49)	** — ** **
<i>Mandible</i>					
Ar-Go	M.	44.17 (5.19)	44.51 (4.27)	42.95 (4.21)	NS
	F.	42.85 (4.02)	42.79 (4.33)	42.95 (3.07)	NS
Go-Gn	M.	71.44 (6.21)	73.09 (4.68)	70.96 (3.58)	NS
	F.	70.27 (4.55)	70.84 (4.95)	71.51 (5.34)	NS
Ar-Gn	M.	105.22 (6.83)	105.03 (4.91)	103.00 (5.73)	NS
	F.	102.19 (5.51)	101.33 (6.37)	103.25 (4.08)	NS
\angle Ar-Go-Gn	M.	129.61 (5.14)	125.16 (5.34)	128.84 (5.01)	** ** ** —
	F.	129.18 (4.84)	124.72 (5.79)	128.50 (4.28)	** ** ** —
<i>Face Height</i>					
N-ANS	M.	52.41 (4.52)	53.93 (3.08)	53.50 (3.00)	NS
	F.	51.45 (2.90)	52.84 (3.13)	52.92 (3.19)	** * — *
ANS-GN	M.	64.85 (6.57)	64.05 (5.40)	66.11 (4.98)	NS
	F.	63.40 (5.06)	61.25 (5.36)	65.41 (4.18)	** * ** *
<i>Max. Prognathism</i>					
\angle SNA	M.	79.77 (3.32)	79.40 (3.66)	77.99 (3.75)	* — — *
	F.	79.32 (3.52)	79.73 (2.83)	77.78 (4.19)	* — * *
\angle SNPr	M.	81.11 (3.39)	80.24 (3.67)	80.24 (3.70)	NS
	F.	80.88 (3.52)	80.84 (2.75)	80.49 (4.52)	NS
<i>Mand. Prognathism</i>					
\angle SNB	M.	76.60 (3.08)	74.29 (3.87)	72.17 (3.17)	** ** ** **
	F.	76.66 (3.92)	74.43 (3.18)	72.39 (3.60)	** ** ** **
\angle SNId	M.	79.00 (3.43)	75.52 (3.82)	73.28 (3.32)	** ** ** **
	F.	78.34 (3.73)	76.14 (3.01)	73.64 (3.91)	** ** ** **
\angle SNPo	M.	78.15 (3.52)	76.23 (3.70)	73.69 (3.20)	** * ** **
	F.	77.66 (4.23)	76.27 (3.80)	73.92 (3.51)	** — ** **

tA=Comparison between neutrocclusion and Class II, div. 2 **=Significant at 1 per cent level.

tB=Comparison between Class II, div. 2 and Class II, div. 1. *=Significant at 5 per cent level.

tC=Comparison between neutrocclusion and Class II, div. 1.

RESULTS

Cranial Base

Overall cranial base length and anterior cranial base length in the Class II, division 2 cases were significantly greater than in the neutroclusion group—being similar to those of the Class II, division 1 cases. Only in the males was posterior cranial base length greater in the Class II, division 2 group, but this might be an age effect as the difference vanished in the male subgroup.

Cranial base angle in Class II, division 2 was similar to the neutroclusion group.

Mandible

Mandibular linear values (overall length, body length, and ramus length) were similar in all 3 groups. The mandibular angle was significantly less for the Class II, division 2 group than for either control group.

Facial Height

Differences in facial heights were present between the female groups, but not between the male groups. The lack of difference in the males may be an age effect because the male subgroup closely follows the pattern of the female main group. The Class II, division 2 female group showed a reduced lower face height compared with the other two groups, but the upper face height for both Class II, divisions 1 and 2 groups was greater than for the neutroclusion cases.

Facial Prognathism

Maxillary basal prognathism (\angle SNA) was similar in neutroclusion and Class II, division 2 but was less in Class II, division 1. Maxillary alveolar prognathism (\angle SNPr) was similar in all three groups.

Class II, division 2 mandibular basal (\angle SNB) and alveolar (\angle SNId) prognathism fell between the values for neutroclusion and Class II, division 1, differing significantly from both. Chin point prognathism (\angle SNPo) behaved similarly although in the female groups, the difference between neutroclusion and Class II, division 2 was not significant.

Sex Differences in the Class II, Division 2 Group

All linear values were greater for the males. This is not a feature peculiar to Class II, division 2 and has been remarked on in several studies. James (1963) found a larger cranial base angle in his female group, but there was no sex difference in this respect for the Class II, division 2 cases.

DISCUSSION

The group studied was selected on the basis of anteroposterior arch relationship and incisor

inclination only, and, as such, it is extremely heterogeneous with regard both to occlusal and to facial pattern. However, these considerations apply equally to the control groups.

Most results, as might be expected, lie between the values for neutroclusion and Angle's Class II, division 1 and they are significantly different from both in several respects. The practice of many of the investigators who have studied the cranio-facial morphology of distocclusion, of grouping together both Angle's Class II, divisions 1 and 2 cases has obscured the differences between them. Wallis (1963) claimed that Angle's Class II, division 2 forms a basically separate group from Class II, division 1. The present study supports this point of view.

The cranial base angle was not different from that of the neutroclusion group (unlike that of the Class II, division 1 group which was larger), but the anterior cranial base length was significantly larger than in the neutroclusion group and resulted in an increased overall cranial base length. This means that the mandibular articulation with the cranial base was distally positioned compared with the neutroclusion group.

Maxillary prognathism was similar to that of the neutroclusion group, and maxillary alveolar prognathism closely followed maxillary basal prognathism.

Mandibular, mandibular alveolar, and chin point prognathism were all closely related to one another, and the values were all significantly less than in the neutroclusion group except for chin point in the female group, where this difference failed to reach a significant level. However, mandibular retrusion was not so marked as in the Class II, division 1 group, and all mean values for mandibular prognathism were significantly greater for the Class II, division 2 cases.

It has been suggested that the chin point in Class II, division 2 cases is often well developed, giving an appearance of mandibular alveolar retrusion. The mean findings in this study did not support this concept as chin point prognathism closely followed mandibular basal prognathism (the mean difference was less than 2° and was very similar in the neutroclusion and Class II, division 1 groups).

It is suggested that an important skeletal factor in this type of malocclusion is the distal positioning of the mandible which is produced principally by the increased linear dimensions of the cranial base structures.

SUMMARY

Tracings were made of lateral skull radiographs of 46 males and 50 females, aged from 7 to 14 years, and with Angle's Class II, division 2 malocclusion. Eight linear and seven angular

measurements were taken and means and standard deviations are presented for each. Results were compared with those of previously published neutroclulsion and Angle Class II, division 1 groups, using an analysis of variance and Student's 't' tests.

Certain variants of the Class II, division 2 groups differed significantly from the other groups. Overall cranial base length was significantly greater than that of the neutroclulsion group, being similar to the Class II, division 1 group. Mandibular linear values were similar in all three groups, but the mandibular angle was significantly smaller in the Class II, division 2 group than in either control group. In the female main groups only, lower facial height in Class II, division 2 was less than in either control group, but upper facial height was greater than that of the neutroclulsion group, being similar to the Class II, division 1 cases.

Maxillary prognathism was similar to the neutroclulsion group while values for mandibular prognathism fell between those of the control

groups, differing significantly from both in several respects.

Acknowledgements

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THIRD MOLAR ERUPTION AND THE EFFECT OF EXTRACTION OF ADJACENT TEETH

B. S. CRYER, B.D.S., F.D.S., D.Orth.

Senior Lecturer in Orthodontics, Guy's Hospital Dental School

INTRODUCTION

ORTHODONTISTS and oral surgeons have been interested for many years in the high incidence of third molar impaction. In spite of this, investigations into the actual incidence have been remarkably few. Bowdler Henry (1938) recommended early enucleation of developing mandibular third molars following a study of bilateral

The classic work of Bowdler Henry and Marrant (1936) was directed at assessing the likelihood of third molar impaction early enough to make prophylactic measures possible. Serious postoperative complications were reported in 121 out of 633 cases. These included 42 deaths, and this fact must have been a real spur to their investigations. The advent of antibiotics and new surgical techniques have so reduced post-



Fig. 1.—Radiographs showing the effect of absence of $\overline{78}$. $\overline{ED}\overline{DE}$ were extracted early. Subsequently $\overline{75}$ erupted into the arch, but $\overline{5j}$ erupted lingually.

radiographs of 500 undergraduates and 600 children, but does not give the incidence of third molar impaction in the former sample. Björk (1956) stressed the importance of both the definition of impaction and the age of the subjects in computing the frequency of impaction. He found the incidence of lower third molar impaction between 20 per cent and 25 per cent in adult Scandinavian males. Haralabakis (1957) from examination of 553 Greek students, aged between 19 and 39 years, estimated third molar impaction to be 17.5 per cent. Dachii and Howells (1961) found the same incidence, 17.5 per cent for lower third molar impaction among American students.

operative sequelae as to remove the emphasis on avoiding the need for surgical removal of the third molars. Interest has turned more to the front of the arch and in particular to the lower anterior crowding so prevalent in adolescents and young adults. Tulley (1962) in a study of dental students, average age 22 years, showed that only 10 per cent of those with a full complement of teeth had neither lower anterior crowding nor impaction of third molars. In a survey of 1000 London schoolchildren Cryer (1965) found that by 14 years 62 per cent had a degree of lower anterior crowding and of these children 60 per cent showed an increase in crowding between 11 and 14 years.

Lower arch crowding often appears in the middle or late teens or increases where it is already present. Because this is coincident with eruption of the third molar, a cause and effect relationship has been suggested. But the survey already referred to indicates that the influence may start considerably earlier—at the time of eruption of the second molars. This point is illustrated in *Fig. 1* showing radiographs at 10½ years of a case which had lost the lower deciduous molars early. On the left side where the lower third molar is missing there is more room for eruption of the second premolar and spacing

treated in this way and noted some of the possible drawbacks. Thus opinions are fairly strongly divided on this choice of treatment.

This assessment of the result of extraction of lower second molars has been made in the hope of assisting case selection.

METHOD AND MATERIAL

One hundred and fourteen cases where one or both lower second molars had been extracted as part of their orthodontic treatment were examined. Selection of cases was limited to those with

Table I.—DISTRIBUTION OF POINTS

	POINTS
POSITION OF LOWER THIRD MOLARS	(Each lower third molar scored separately)
Vertical in good relations with adjacent teeth and opposing teeth	25
Slight mesial inclination in good relations with adjacent and opposing teeth	20
Vertical and spaced adequate for self-cleansing	10
Contacting first molar, but with severe mesial inclination	5
Impacted or erupted with severe mesial inclination and spacing	—
DISIMPACTION OF PREMOLARS	(Each lower quadrant scored separately)
Where extraction of lower second molars has relieved impaction of premolars caused by early loss of deciduous molars	10
LOWER ANTERIOR ALINEMENT	
Considerable reduction in crowding	20
Slight reduction in crowding	15
No change in crowding	10
Slight increase in crowding	5
Severe increase in crowding	—
NEED FOR LOWER APPLIANCE	
Result achieved without lower appliance	10
Result achieved with one lower appliance	5
Result achieved with more than one lower appliance	—

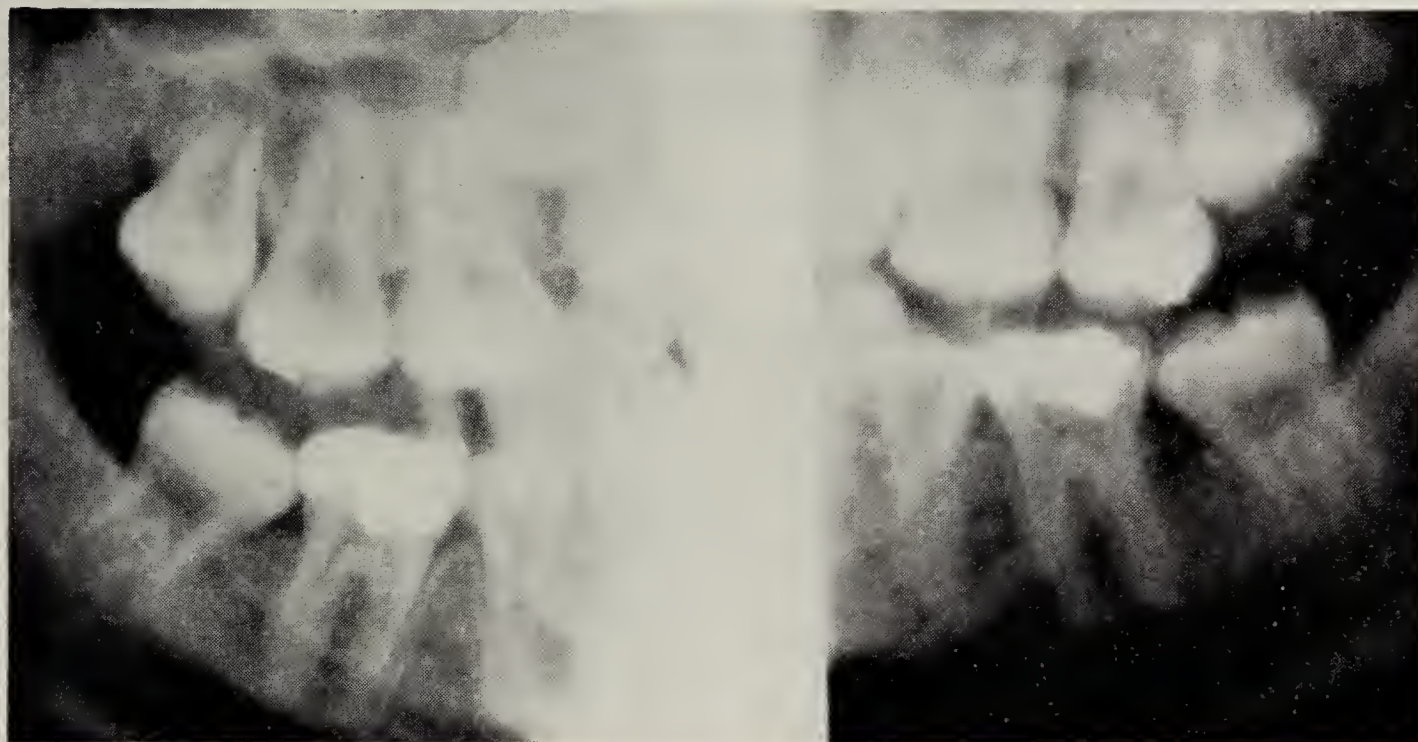
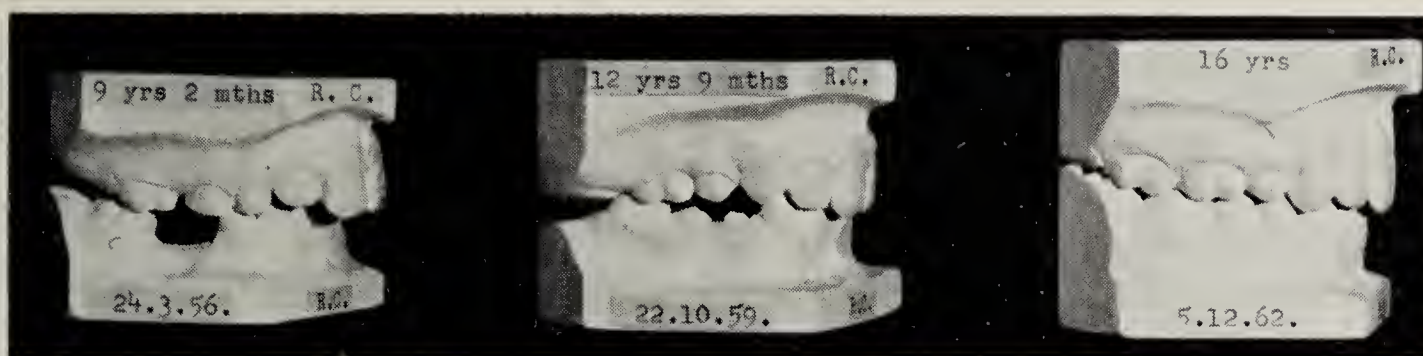
between the first and second molars. On the left the lower second premolar erupted into good position, but on the right it erupted lingually because of lack of space in the arch.

Weinmann and Sicher (1947) referring to the evolutionary trend towards smaller jaws as an aggravating factor in arch crowding and third molar impaction say, 'The gradual reduction in the length of the jaws and the reduction in the dentition are not entirely correlated'.

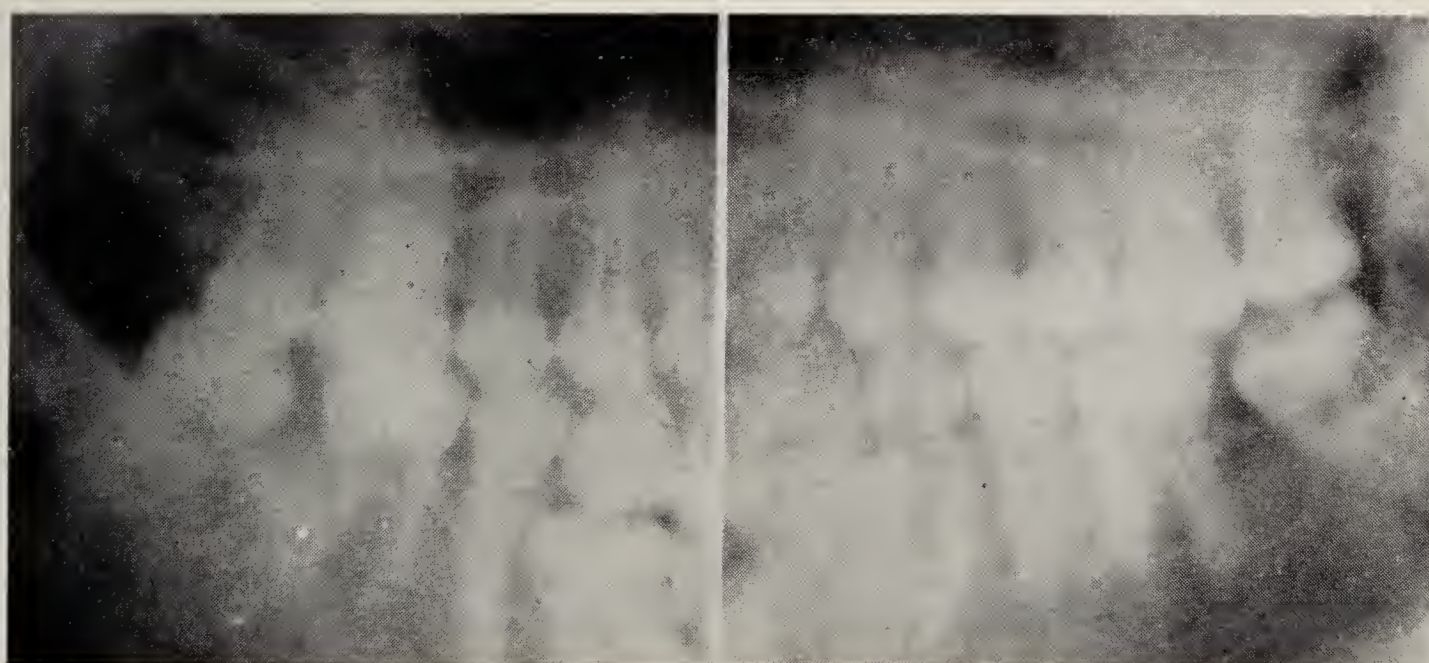
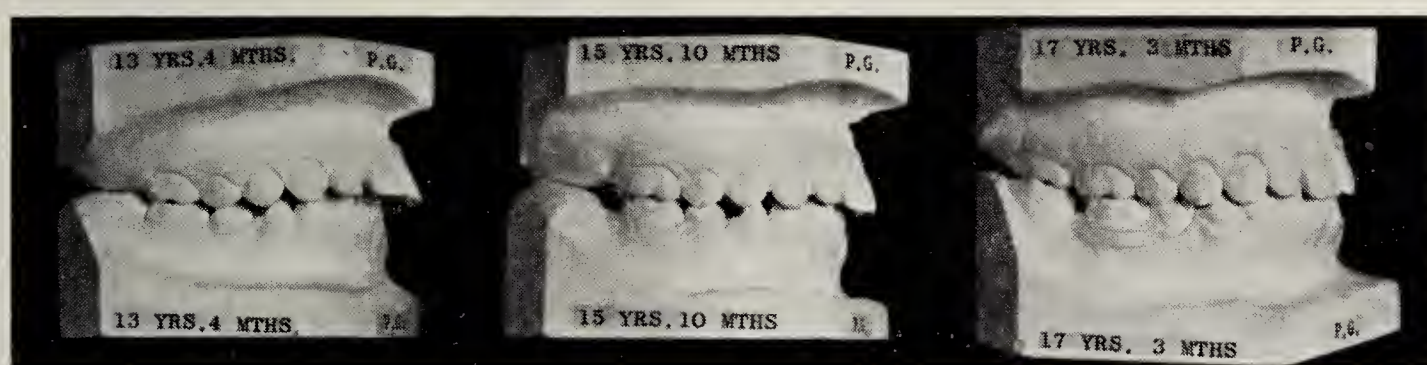
The combination of arches which are short anteroposteriorly and the early loss of deciduous molars frequently results in impaction of premolars. As a result, in the lower arch the premolar is often lingually inclined but where the premolar does erupt vertically it is frequently accompanied by an increase in lower anterior crowding. The extraction of second permanent molars has been suggested as a possible treatment to prevent this effect. Smith (1957), Rix (1960), and Chipman (1961) have all shown cases

adequate records. These consisted of treatment summary, serial record models, and radiographs. Lateral oblique radiographs were sometimes supplemented by intra-oral and lateral skull radiographs. Patients in their late teens and early twenties appear very reluctant to return for final records, especially if they have had several years of orthodontic treatment. This was an unfortunate factor in reducing the full assessment to 66 cases.

Hallett and Burke (1961) drew attention to the difficulty of assessment of similar clinical material in relation to first permanent molar extractions. They settled for a subjective 'ranking' method. In this assessment I have used a points system to facilitate comparison of case results. This was based on the aims of treatment in extracting lower second permanent molars. First, the elimination of potential third molar impaction; secondly, the reduction of lower arch crowding, particularly the relief of premolar impaction



A



B

Fig. 2.—A, Good result. Case 30. Details of this case are recorded in Table II. B, Fair result. Case 23. Details of this case are recorded in Table II.

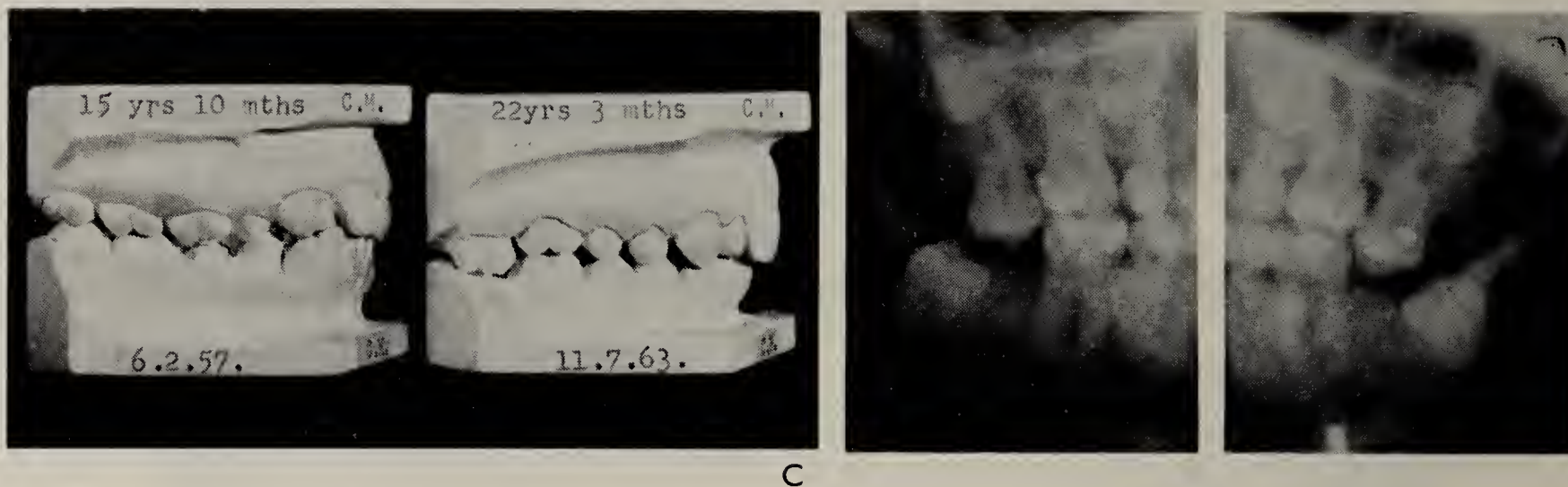


Fig. 2. (cont'd).—C, Poor result. Case 10. Details of this case are recorded in Table II.

Table II.

		CASE 10	CASE 23	CASE 30
CASE ASSESSMENT	<i>Skeletal Classification</i>	Class I	Class I	Class II (mild)
	<i>Dental Classification</i>	Class I	Class II, div. 1	Class II, div. 1
	<i>Age at the time of $\overline{7 7}$ extractions</i>	17 yr.	15 yr.	12 yr. 4 mth.
	<i>Stage of $\overline{8 8}$ Develop</i>	Crown Formed	Roots Forming	Crown Formed
	<i>Develop Position of $\overline{8 8}$</i>	$\overline{8 }$ mid. $\overline{ 8}$ mid.	$\overline{8 }$ mid. $\overline{ 8}$ mid.	$\overline{8 }$ mid. $\overline{ 8}$ mid.
	<i>Angle of $\overline{8 8}$ to $\overline{6 6}$</i>	$\overline{8 }$ 17° $\overline{ 8}$ 32°	$\overline{8 }$ 28° $\overline{ 8}$ 29°	$\overline{8 }$ 16° $\overline{ 8}$ 34°
TREATMENT RECORD	<i>Upper Arch Extractions</i>	—	$\overline{7 7}$	$\underline{4 4}$
	<i>Upper Arch Treatment</i>	Removable Appliance 6 mth.	Removable Appliance 5 mth., Monobloc 1 yr. 8 mth.	Removable Appliance 2 yr. 6 mth.
	<i>Lower Arch Extractions</i>	$\overline{7 7}$	$\overline{7 7}$	$\overline{7 7}$
	<i>Lower Arch Treatment</i>	No Appliance	Removable Appliance 10 mth.	No Appliance
RESULTS	<i>Occlusion of $\overline{8 8}$</i>	—	40	45
	<i>Disimpactions of $\overline{54 45}$</i>	—	—	20
	<i>Lower Anterior Alinement</i>	10	10	5
	<i>Use of Lower Appliance</i>	10	5	10
	TOTAL	20	55	80

following early loss of deciduous molars; thirdly, the prevention of lower anterior crowding so prevalent in young adults. *Table I* shows how each of these features was subdivided and scored.

The following factors influenced the decision on the points value of each objective. Without exception, the lower second permanent molar was in good position before extraction, therefore, unless the third molar replacing it was vertical or only slightly mesially inclined, a low score was recorded.

Regarding premolar disimpaction, since this was a chief aim of the treatment unless it was completely successful, no points were scored; nor were any points scored if the premolars were fully erupted prior to second molar extraction.

A degree of success was registered by the points awarded where no change or only a slight increase in lower anterior crowding occurred. Where there was either a slight or considerable improvement in lower anterior crowding higher scores were recorded.

The added advantage of obtaining a result without need for lower appliances was included as a factor in assessing the result.

Points were scored for each case according to *Table I* depending on the degree to which they fulfilled the aims of treatment.

There were 7 cases in which only one lower second permanent molar was extracted because of absence of the third molar on the opposite side or extraction of other teeth. Rather than reject these from the assessment, the score for the remaining third molar position and premolar disimpaction was doubled to provide a comparable total to the bilateral extraction cases. Reference to these unilateral cases is made in the results.

I decided to make an arbitrary division of the results into 3 groups:—

70 points plus—good results

40 points plus—fair results

Below 40 points—poor results.

Since the final position of the lower third molar was considered to be of particular interest the scores for the lower third molar alone were also recorded and analysed into 3 groups:—

20 points plus—good results

10 points plus—fair results

Below 10 points—poor results.

In addition to the points scored for each case the following details were recorded:—

Skeletal and dental classification and at the time of lower second permanent molar extractions, age, stage of development of lower third molars, vertical developmental position of lower third molars, and angulation of lower third molars to lower first molars.

Treatment details recorded included upper arch extractions, types of appliances used in both upper and lower arches, and the length of time they were worn.

Because of the nature of the material it was decided not to analyse the results statistically, but to place more emphasis on their clinical implications.

RESULTS

The results are set out in the form of histograms. To illustrate the method of analysis three cases are shown in *Table II* as examples of good, fair, and poor scores. Their record models and radiographs are shown in *Fig. 2*.

Table III shows the 66 cases divided according to Angle's classification and the distribution of the results.

Fig. 3A is a histogram showing the relationship between age at the time of lower second permanent molar extractions and the treatment result. The number of good results and the fair and poor combined are given for each age to allow comparison. As mentioned earlier, the result refers to the combined features of the final occlusion for which points were awarded. In the histogram in *Fig. 3B* the relationship is between age at the time of lower second permanent molar extractions and final position of lower third molars.

Fig. 4 is a distribution graph showing the wide variation in age for the various stages of lower third molar formation found among the cases in this study.

Fig. 5A is a histogram showing the relationship between stage of third molar formation at the time of lower second permanent molar extractions and the overall treatment result. Assessment of third molar formation was limited to 4 stages. Again the good results are compared with the fair and poor results combined.

Fig. 5B is a histogram showing the relationship between the stage of lower third molar development at the time of extraction of lower second permanent molars and the final position of the lower third molars.

Fig. 6 is a histogram showing the relationship between developmental position of the lower third molar at the time of lower second permanent molar extraction and the overall treatment result. A middle developmental position was recorded when the occlusal surface of the developing third molar was level with the bifurcation of the roots of the lower second permanent molar. Low and high positions of the developing third molar were recorded for occlusal levels below and above the bifurcation of the lower second permanent molar respectively.

Fig. 7 is a histogram showing the relationship between angulation of the lower third molar at the time of extraction of the lower second permanent molar and the treatment result. A line drawn at right-angles to the occlusal surface of the developing third molar was used as its long axis in measuring the angle between the third and

first permanent molars. As previously the good results have been recorded separately from the fair and poor results. The problem of taking accurately reproducible lateral oblique radiographs on subsequent occasions has not yet been overcome. Rose (1960) has drawn attention to the effect of variation of angulation and position of the X-ray tube on extra-oral films. Therefore

lower arch crowding by second molar extractions is about equal in Class I and Class II malocclusions. Perhaps the most definite point was made by exclusion, no Class III cases were found in which lower second permanent molars had been removed. This is not surprising since lower third molar impaction is least likely in the

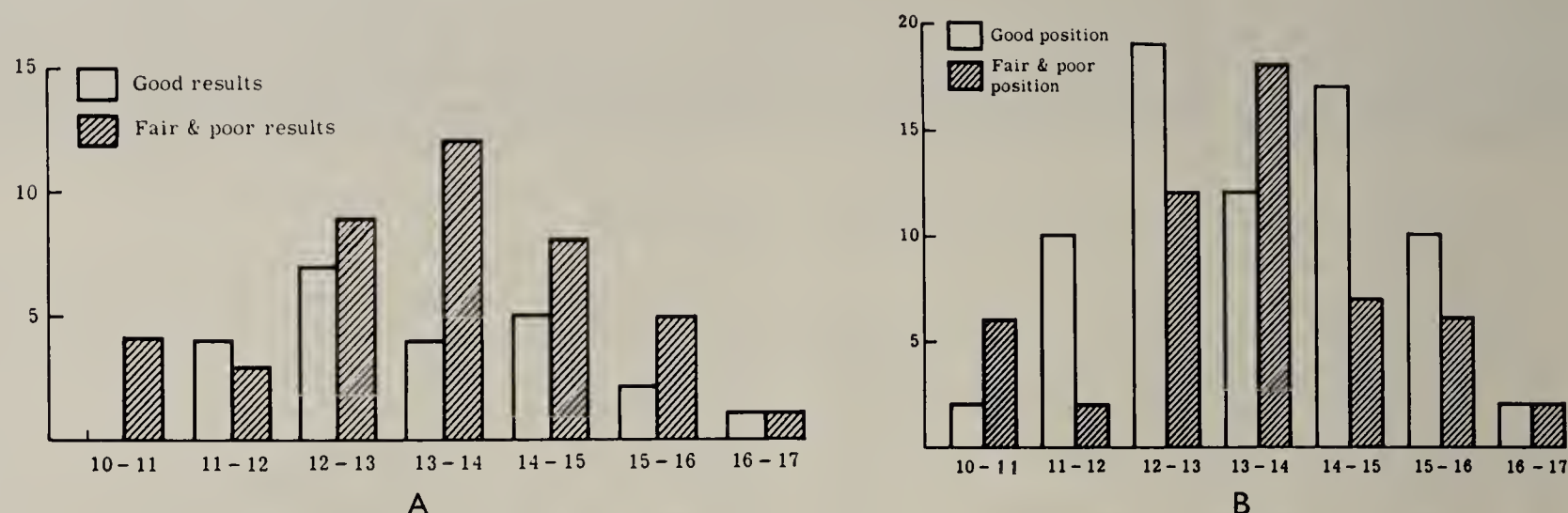


Fig. 3.—A, Relationship between age at the time of lower second molar extractions and the overall treatment result. B, Relationship between age at the time of lower second molar extractions and final position of lower third molars.

Table III.—RESULTS OF THE 66 CASES SUBDIVIDED USING ANGLE'S CLASSIFICATION

DENTAL BASE RELATIONSHIP	OCCUSAL RELATIONSHIP	GOOD (70 POINTS +)	FAIR (40 POINTS +)	POOR (BELOW 40 POINTS)
Class I	Class I	5	9	7
	Class II, div. 1	2	2	—
Class II (mild)	Class II, div. 1	7	6	4
	Class II, div. 2	3	4	2
Class II (severe)	Class II, div. 1	5	4	3
Class III (mild)	Class I	1	1	1
Class III (severe)	Class III	—	—	—
	TOTAL	23	26	17

some reservation must be made on the degree of accuracy, particularly angular measurements, from these films.

DISCUSSION

When the cases are divided into the small groups shown in Table III their numbers are too small to draw any but the most general conclusions. They suggest that the success in treating

comparatively large lower arch of most Class III malocclusions.

In a third of the cases (23 out of 66) the results were considered to be good on the basis of final third molar position, disimpaction of premolars, and lower anterior alignment. The information recorded from each case was chosen to see if there were any factors common to the good result group which could be used as aids to case selection.

The factors related to the overall treatment result in the histograms in *Figs. 3–7* were chosen because in deciding on lower second permanent molar extractions attention is focused on the lower third molar and its position.

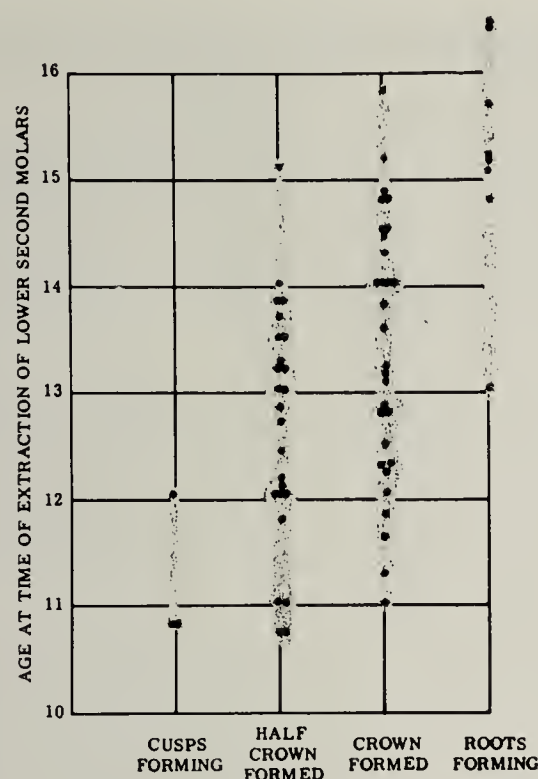


Fig. 4.—Relationship between age and third molar development.

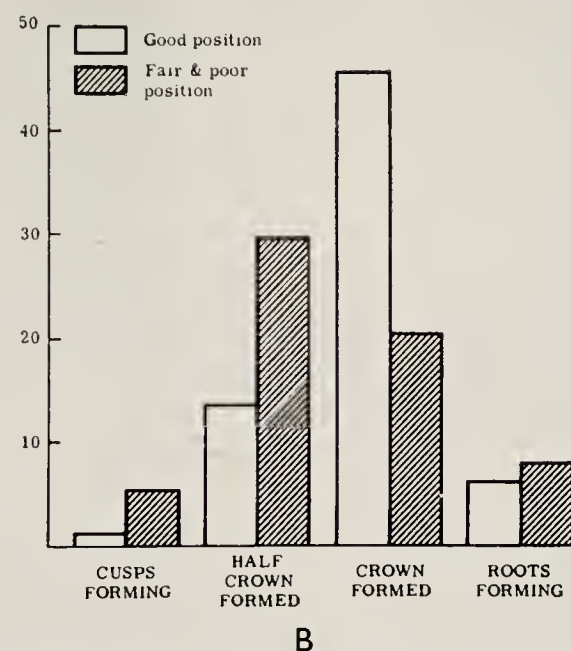
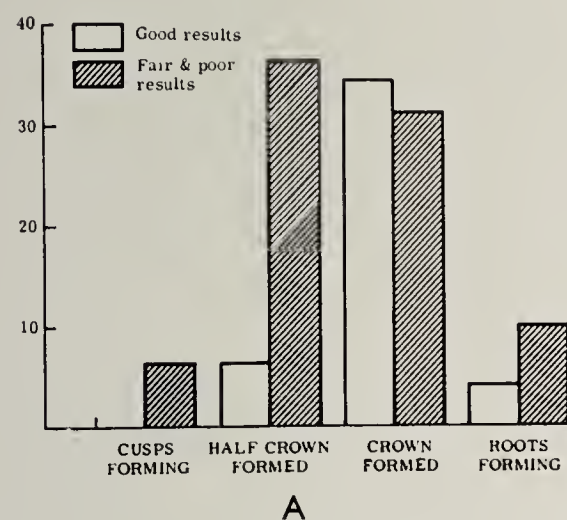


Fig. 5.—A, Relationship between stage of lower third molar development at the time of extraction of lower second molar and the overall treatment result. B, Relationship between stage of lower third molar development at the time of extraction of lower second molars and final position of lower third molars.

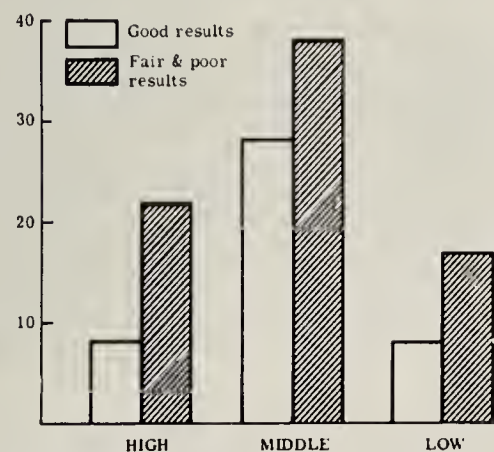


Fig. 6.—Relationship between position of lower third molar at the time of extraction of lower second molar and the overall treatment result.



Fig. 7.—Relationship between angulation of lower third molar at the time of extraction of lower second molar and the overall treatment result.

Judging by the distribution of the good results and the fair and poor combined shown in *Fig. 3A*, there is no optimum age when the extraction of lower second permanent molars will ensure success of the overall treatment result. In *Fig. 3B* where only the final position of the third molar is considered there is a notable increase in the proportion of good results. Between 12 and 15 years 56 per cent of lower third molars finish in a good position.

The variability in the time of formation of the lower third molar shown in *Fig. 4* could explain the lack of association between age and successful treatment result, should the latter be linked to stage of third molar development. The conclusion from the results in *Fig. 5A* is that the highest proportion of successful overall treatment results occur when the lower second permanent molar extractions coincide with complete crown formation of the lower third molar. The age-range for this stage shown in *Fig. 4* is 11 to nearly 16 years. Among possible explanations for the success in this group is the fact that it includes some in their middle teens. In these, at least,

there would be little doubt of the degree of lower arch crowding being correctly assessed. Where the final position of the lower third molar is the only criterion for success the indication is even stronger for extraction of the lower second

extraction. Cases with greater angulation have ended up satisfactorily. Rix (personal communication) accepts an angulation of up to 45° as suitable. From the cases in this survey it does appear that the greater the initial angulation of

DIFFERING PATHS OF ERUPTION

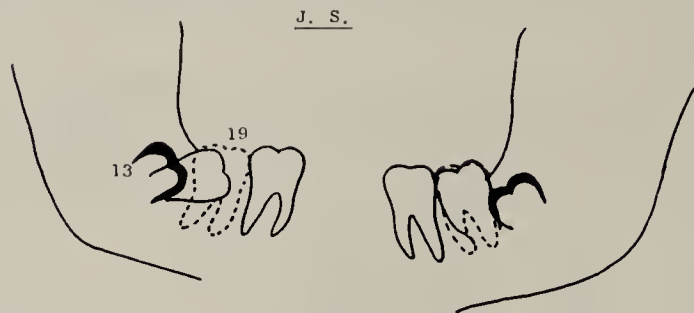


Fig. 8.—Tracings from radiographs superimposed on $\overline{6|6}$. Position of $\overline{8|8}$ at the time of extraction of $\overline{7|7}$ shown by heavy outline. Broken line shows position of $\overline{7|7}$. Continuous line shows final position of $\overline{8|8}$.

VARIATION IN SPEED OF ERUPTION

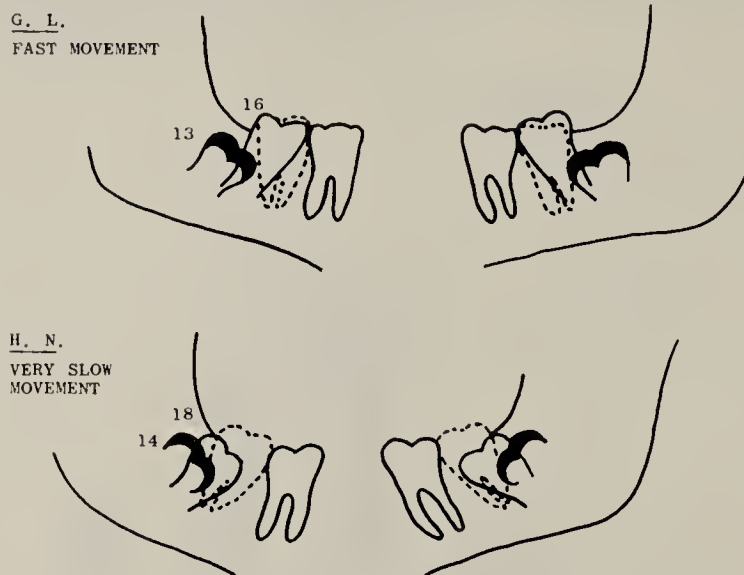


Fig. 9.—Tracings from radiographs superimposed on $\overline{6|6}$. Position of $\overline{8|8}$ at the time of extraction of $\overline{7|7}$ shown by heavy outline. Broken line shows position of $\overline{7|7}$. Continuous line shows position of $\overline{8|8}$.

permanent molar to coincide with crown formation of the lower third molar. Fig. 5B shows that 70 per cent of lower third molars under these circumstances reach a good final position.

From Fig. 6 it would seem that there is no obvious connexion between the development position of the lower third molar in the vertical plane at the time of lower second permanent molar extractions and the success of the overall treatment result.

It would be a mistake to take the angular measurements of Fig. 7 as indicating anything more than a trend because of their limited accuracy. They do suggest a higher proportion of good overall results when the angulation of lower third to lower first permanent molars is below approximately 30° at the time of lower second molar

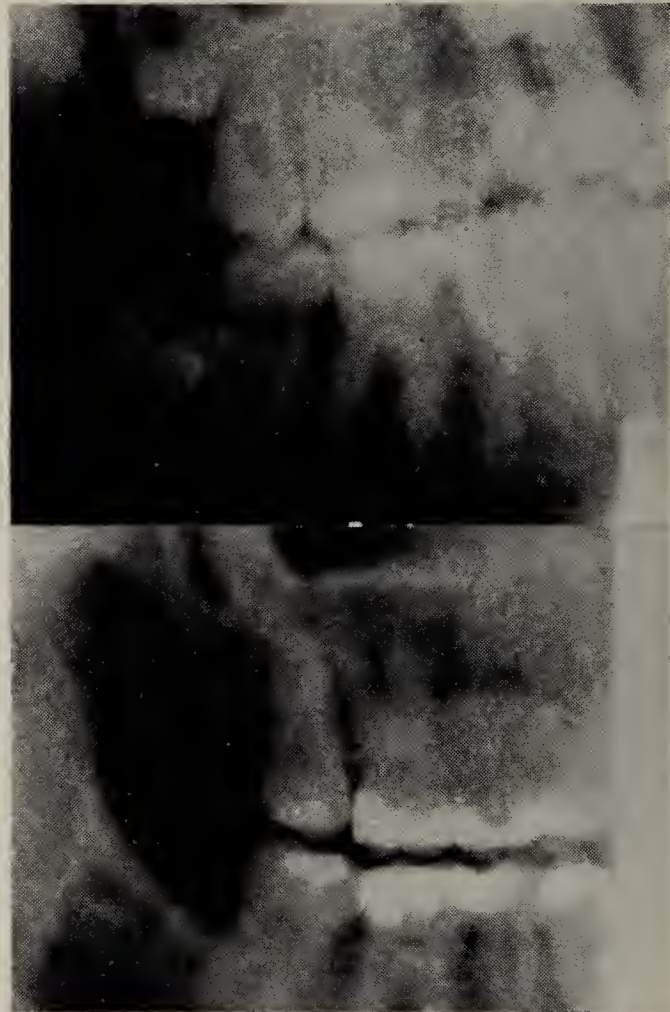
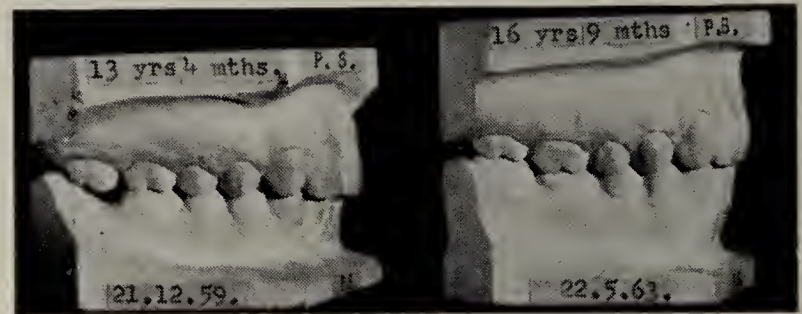


Fig. 10.—Extraction of $\overline{7|7}$ at 12 years. Models before and after extraction of over-erupted $\overline{7|}$. Radiographs to show initial and final position of $\overline{8|}$ and $\overline{8|}$.

the lower third molar the less likely is the final position to be vertical. Initial angulations over 45° have the added risk of converting a potential mesio-angular impaction of the lower third molar into a horizontal one. Fig. 8 shows tracings of the radiographs of a case in which the initial angulation of the lower third to lower first molars was 18° on the left and 55° on the right. Following extraction of the lower second molars the lower left third molar erupted into a good position, but the lower right has become more horizontal.

Variability seems the most apt description of lower third molar behaviour. The tracings of 2 cases in Fig. 9 show this in relation to the rate of eruption. Garn, Lewis, and Polacheck (1960) explain this on the basis that the variability of all

developmental phenomena increases in an almost linear way with age.

Apart from the formal investigation, because of the clinical nature of this paper, some case results are included. These illustrate some of the indications for this treatment and also the many pitfalls.

Over-eruption of unopposed upper second permanent molars has already been shown (*Fig. 2C*). This may prevent distal movement of the

the subsequent over-eruption of the unopposed upper second permanent molars. These were then extracted, and the models at 16 years 9 months and the radiographs show the final position of the third molars.

However, where upper premolar extractions have been carried out, and residual space exists, upper second molar extractions may be contra-indicated. Therefore, where the occlusion will not

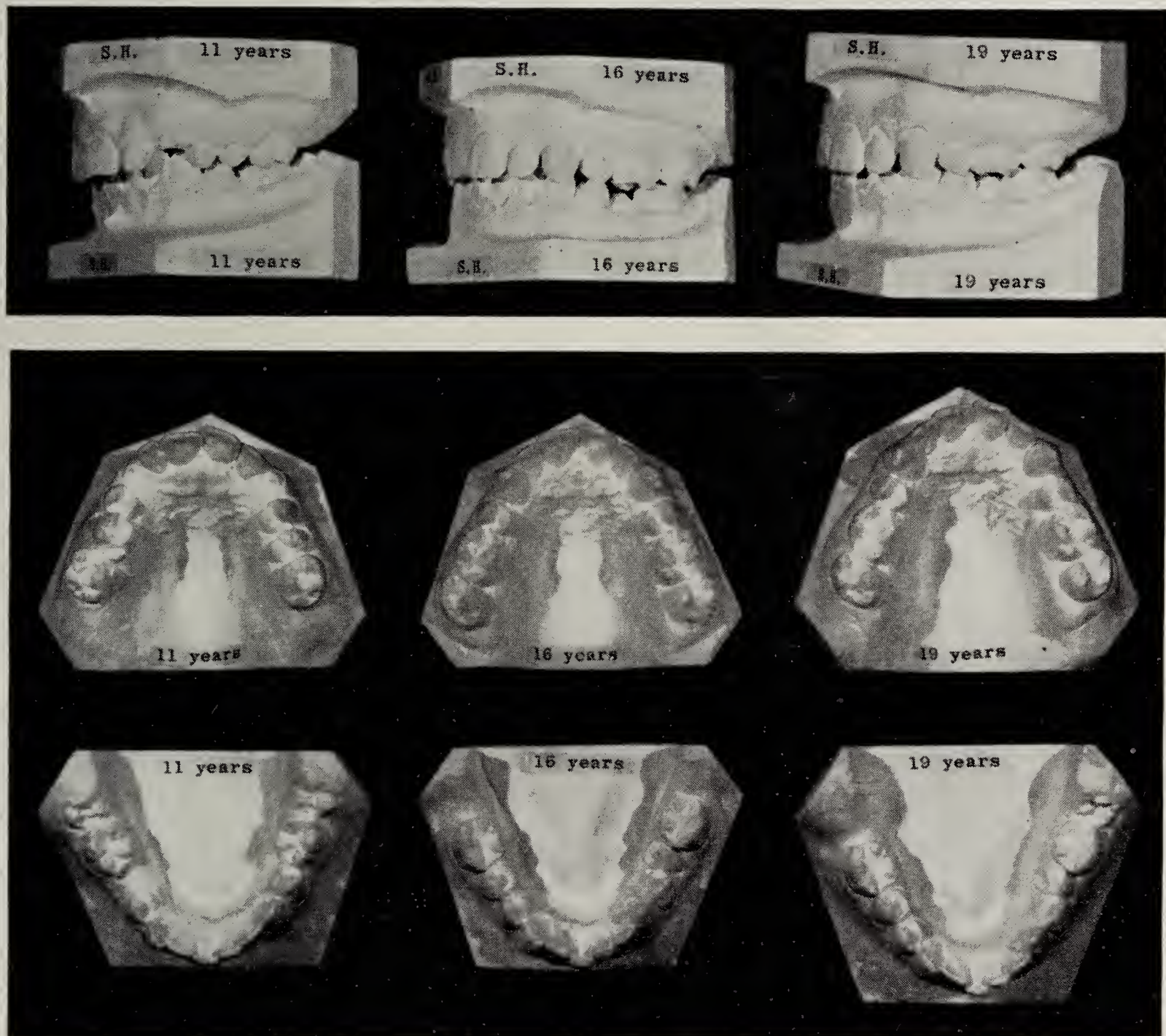


Fig. 11.—Models showing that $\overline{75}$ failed to erupt fully following extraction of $\overline{77}$.

lower first permanent molars and subsequent relief of premolar impactions as well as any chance of improvement of lower anterior crowding. In addition, symptoms may be caused immediately prior to eruption of the lower third molar because of trauma to the overlying soft tissues. Sometimes it may be possible to extract the over-erupted upper second permanent molar and obtain a satisfactory result. *Fig. 10* shows records of a case in which the lower second permanent molars were extracted at 12 years. Upper arch treatment was limited to closing anterior spacing following loss of the upper right central incisor. The models at 13 years 4 months show

prevent this over-eruption occurring the appliances used in upper arch treatment should carry occlusal rests on the upper second permanent molars.

The importance of careful examination of the conservative condition of the teeth before the extraction of the lower second molar is emphasized by the fact that in three cases lower first permanent molars were subsequently lost. This occurred bilaterally once and unilaterally twice among the 66 cases.

The degree of lower arch crowding that can be relieved by lower second permanent molar extraction is limited. *Fig. 11* shows the models

of a case in which initially the lower left first premolar and first permanent molar were in contact over the unerupted second premolar. Following extraction of the lower second permanent molars the lower right second premolar erupted, but

ing lower second permanent molar extractions. As an example, *Fig. 12* shows models of a case before and 3 years 8 months after treatment. The upper right first and upper left second premolars were extracted at 12 years, followed by the use of

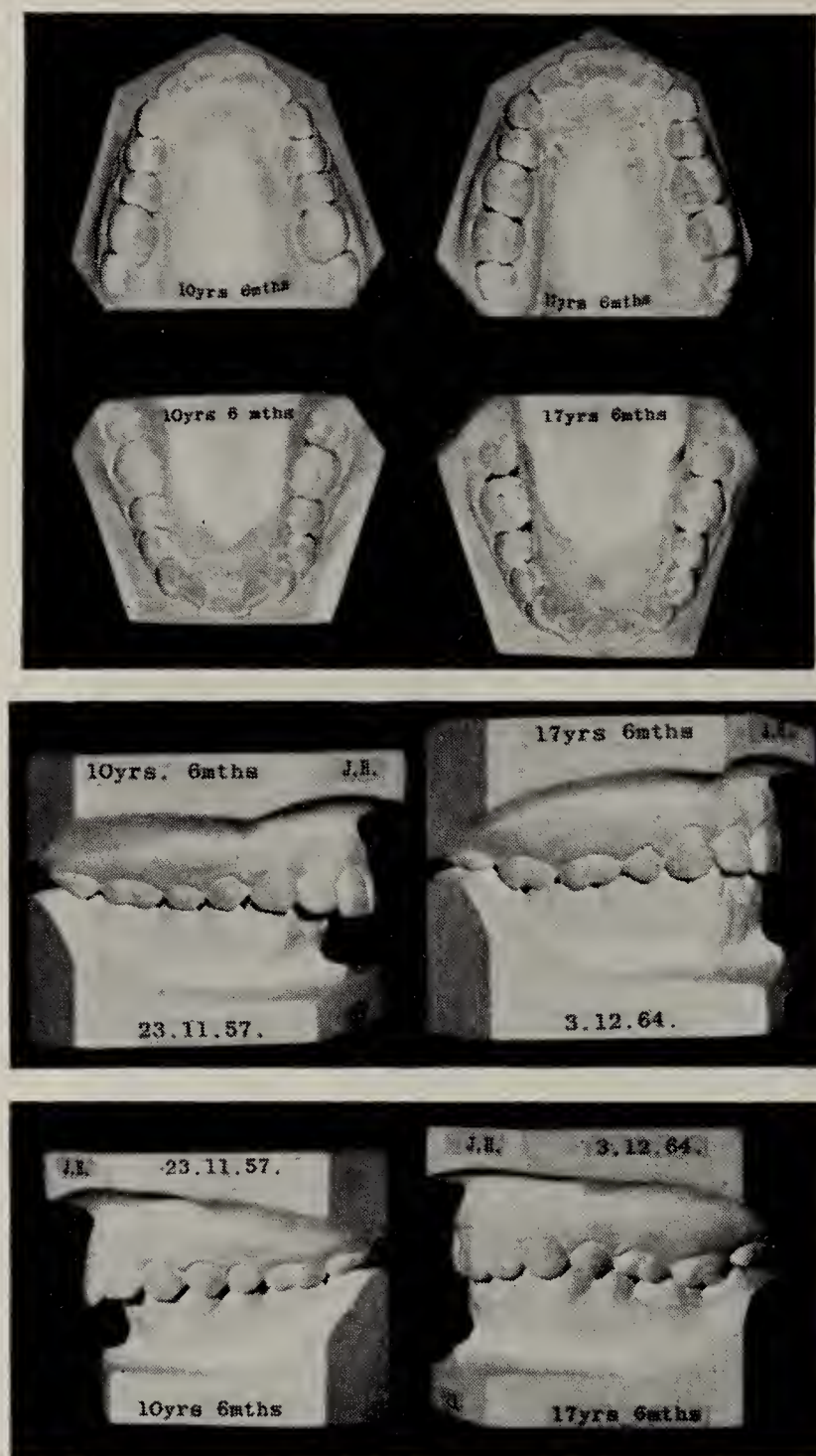


Fig. 12.—An example of improvement in lower anterior alignment by the use of appliances following extraction of $\overline{77}$ at 13 years 9 months.

treatment extended over 2 years, involving 5 appliances, without completely disimpacting the lower left second premolar. In addition, there was an increase in the lower anterior crowding. Eruption of the lower left third molar was accompanied by pericoronitis, which necessitated antibiotic treatment. This was an exception to the usual finding in this survey. In nearly every case the eruption of the lower third molars was not accompanied by any discomfort caused by soft-tissue inflammation. Such discomfort is all too frequent when the lower third molar has insufficient space to erupt.

There is no doubt that some improvement in lower anterior alignment can be achieved follow-



Fig. 13.—Case treated by extraction of $\frac{4}{4}$ $\frac{7}{5}$ and only upper appliances. Subsequently $\frac{8}{1}$ erupted into good position, but $\overline{8}$ had to be extracted.

upper appliances for 2 years. The lower second permanent molars were removed at 13 years 9 months when the crowns of the lower third molars were fully formed. Lower arch treatment lasted 1 year 6 months, and required 2 appliances. In the 66 cases in this survey lower anterior alignment remained the same in 27 cases, slightly improved in 21 and greatly improved in 6. A slight deterioration occurred in 11 cases and severe deterioration in only 1 case.

Fig. 13 illustrates two different paths of eruption of lower second premolars in a crowded arch. In the upper arch the first premolars were extracted at 10 years 7 months and appliances

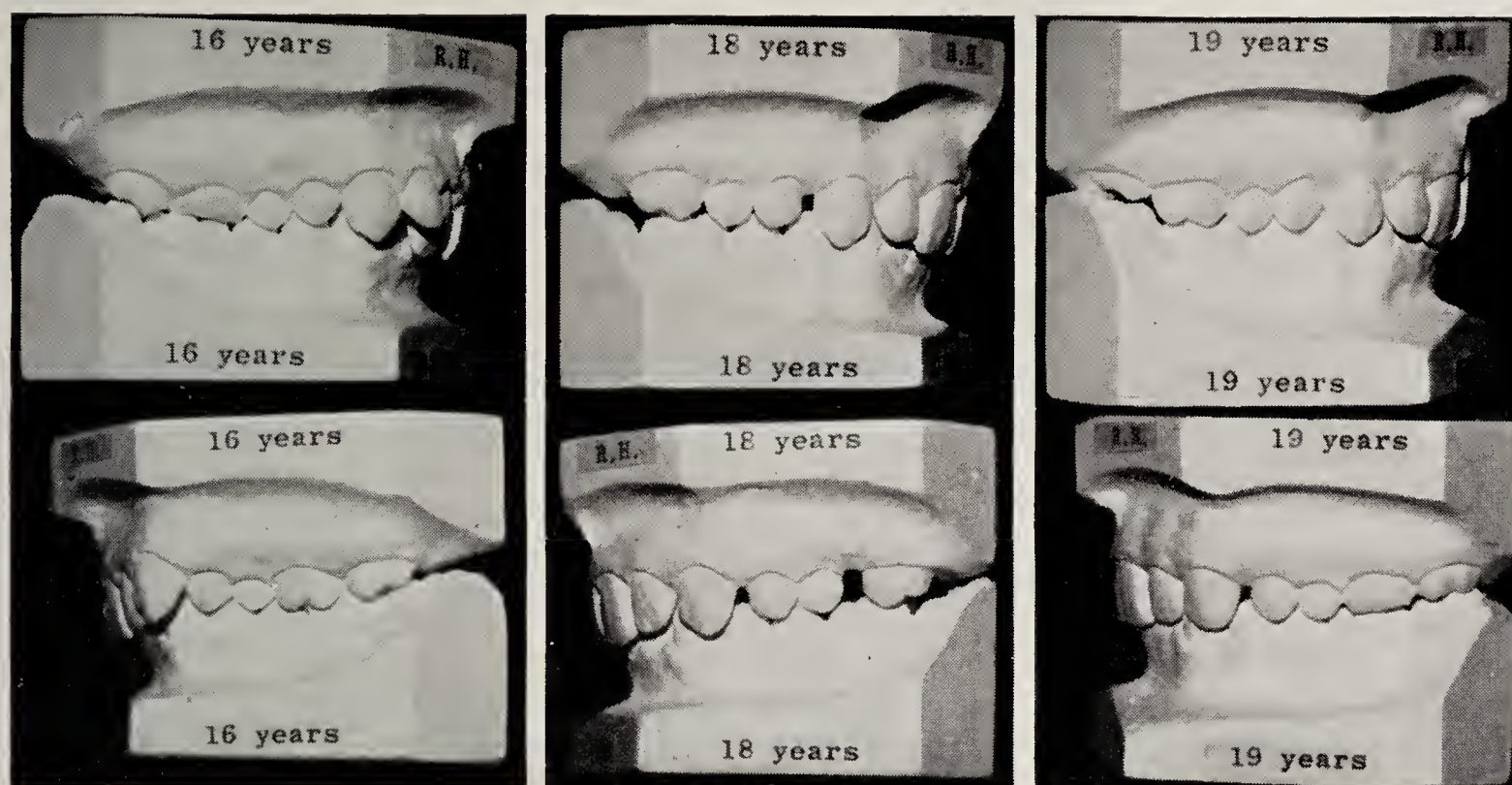
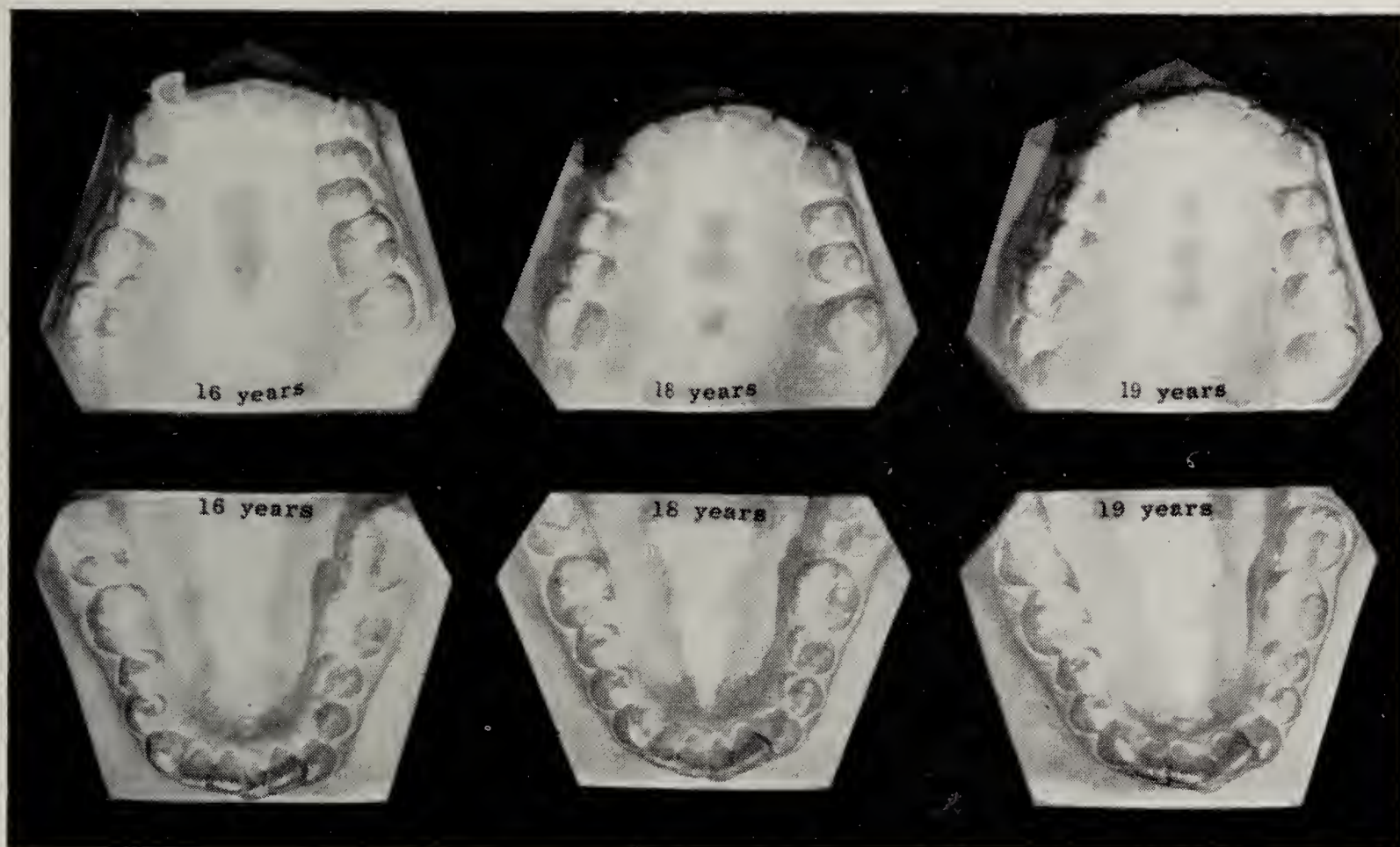
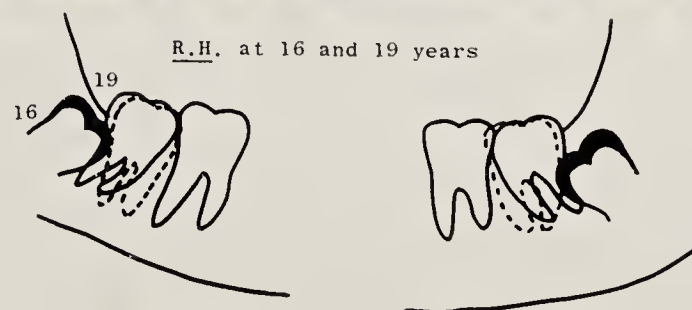


Fig. 14.—Favourable result in older patient. Extraction of $\overline{6|6}$ and $\overline{7|7}$ at 16 years 6 months and upper appliance for 1 year 2 months only. Tracings superimposed on $\overline{6|6}$. Position of $\overline{8|8}$ at the time of extraction of $\overline{7|7}$ shown by heavy outline. Broken line shows position of $\overline{7|7}$. Continuous line shows final position of $\overline{8|8}$.



used for 1 year 6 months. The lingual inclination of the lower left second premolar was an additional reason for its extraction, together with the lower right second permanent molar, to relieve the crowding. The resultant occlusion is shown at 13 years, and there is enough contact

between the lower right first molar and the upper second molar to prevent its over-eruption.

Subsequently, the lower right third molar erupted into good position, but after repeated episodes of pericoronitis the lower left third molar was extracted.

Out of the other 6 cases in which only 1 lower second permanent molar was extracted, 3 cases showed impaction of the third molar on the opposite side, in 2 cases the third molar erupted following extractions further forward, and in 1 case there was congenital absence of the third molar.

Lingual inclination of the lower second premolar is not necessarily a contra-indication to extraction of the second permanent molar where the amount of additional space required is small. Spontaneous improvement from such a position may occur, particularly if an upper appliance is being worn which unlocks the occlusion. Usually a lower appliance will be needed. Of the cases in this survey 38 were treated without lower appliances, 10 required one appliance, and 18 two or more.

The case in *Fig. 14* illustrates some of the features common to patients who present requesting orthodontic treatment in the middle teens. The chief concern was upper anterior irregularity; in this case the proclined right lateral incisor. There was a degree of lower anterior crowding and impending third molar impaction. The upper first permanent molars were very heavily filled. The upper first and lower second molars were extracted at 16 years 6 months, when the roots of the lower third molars were already forming. Only upper appliances were used for 1 year 2 months. The later models and the tracings from radiographs show the improved occlusion and path of eruption of the lower third molars. This result is better than the survey suggests could be expected and emphasizes the difficulty in applying general trends to an individual case.

SUMMARY AND CONCLUSIONS

Sixty-six cases were investigated in which the orthodontic treatment included extraction of the lower second permanent molars.

The results on the basis of the final position of the lower third molars and the relief of crowding was assessed as: good 35 per cent, fair 40 per cent, and poor 25 per cent.

No optimum age was found for the extraction of the lower second permanent molars to ensure success of the overall treatment. But the survey showed that when the lower second permanent molars were extracted between 12 and 15 years, 56 per cent of the lower third molars erupted into a good position. There was a higher proportion of good overall results and 70 per cent of lower third molars in good final position when the extraction of the lower second permanent molars coincided with full crown formation of the third molars.

Lower third molars more frequently erupted into a good position when their angulation to the long axis of the first molar was less than 30°—at the time of extraction of the lower second molars.

A series of cases from the survey was included to illustrate some of the advantages and limitations of this treatment.

The conclusions are that there is a definite place for the extraction of lower second permanent molars both with and without appliance therapy.

The degree of lower arch crowding that can be successfully relieved by these extractions is small. The usual benefit in this respect is in preventing the increase in lower anterior crowding so frequently seen in this age-range.

By careful selection of cases for extraction of lower second permanent molars, a high proportion of third molars will erupt into good position and without any of the accompanying soft-tissue discomfort so often experienced. However, it is not a panacea for all lower third molar impactions. Modern surgical techniques and antibiotics make it unnecessary to extract the lower second molars merely to avoid the probable need for later surgical removal of the third molars.

If the limitations of this treatment are accepted, and the necessary precautions taken, an increase on the 35 per cent of good results in this survey should be expected.

Acknowledgements

I would like to thank Mr. Rix, Mr. Pringle, and Professor Tulley for permission to show cases that were under their care. I am very grateful to the staff of the Departments of Medical Illustration and Dental Photography for the preparation of the illustrations, and to Mrs. Rawlins and Mrs. Budge for secretarial assistance.

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DISCUSSION

Mr. D. A. Plint, opening the discussion, congratulated Mr. Cryer on his being awarded the Chapman prize.

He wished to make a point about the choice of extractions in the lower arch, especially regarding crowding in the lower incisor region. This depended, he thought, on whether the extractions were carried out to overcome a moderate to severe degree of crowding or merely as a prophylactic measure in preventing an increase in lower incisor crowding.

If a good result could be guaranteed in only 35 per cent of cases, in respect of the final position of third molars, was the loss of these teeth warranted in cases where the only indication was a possible increase in lower incisor imbrication? If the second molars were not chosen, what other teeth or groups of teeth could be selected? Had Mr. Cryer any views on the enucleation of lower third molars?

It was only fair to point out that one often saw the reappearance of lower incisor crowding in cases successfully treated initially by the extraction of lower first premolars.

Mr. Cryer's results showed that only a small number of cases showed a deterioration in the lower incisor crowding following the loss of second molars: 12, in fact, out of the 66 cases. It would be interesting to compare a similar group of cases where first premolars had been extracted in respect of later changes in the lower incisor crowding.

Personal bias was always a factor where clinical assessments were made. Mr. Cryer had tried to minimize this by his point system. He had only one query: would it not have been an advantage to assess the complexity of the lower treatment on a time basis, rather than on the number of appliances used? But this was a minor criticism, especially as the number of points involved was small.

Finally, a few words about the results; had Mr. Cryer noted any rotations of third molars and resulting doubtful contact points, or had his assessment been made entirely on axial inclination?

He was surprised to note on the histogram comparing age and result of treatment that there were no good results recorded in the very early age-group, of 10 to 11 years. Only fair or poor results were seen in the overall treatment result. Even when assessing the final position of the third molars on their own, still very few good results appeared in the 10 to 11-year-old group. Mr. Cryer's comments on this would be interesting, and also on why the 13 to 14-year-old group was less good than those groups on either side. This was a large group, and many would have thought a good age for assessment.

A factor that might have influenced the final result in the very early age-group was that early eruption of second molars was often associated with early loss of deciduous molars and forward movement of first molars with resulting crowding out of second premolars. The poor final position of these second premolars might have contributed to the overall treatment result.

He expected that, tied up with the above, was the age of tooth calcification, as this might be a better indication of tooth development than chronological age. Mr. Cryer had shown that one could afford to be patient—in fact, wait until 15 or 16—and still have a more than equal chance of success. He wondered whether, indirectly, it was more difficult to make an assessment of the axial inclination of the third molars?

Mr. Cryer thought that Mr. Rix had been the first to recommend lower second molar extractions at Guy's. Among the reasons was consideration for the patient for it avoided a surgical approach to the third molars. He believed Mr. Bowdler Henry had recommended enucleation of third molars at about nine years of age. He thought in suitable cases the effect on the lower arch would be similar to lower second molar extractions.

He would be very interested to see a similar survey, as Mr. Plint had suggested, of cases in which lower premolars had been extracted and to compare the results. He did not think it had been done and after the vicissitudes of this present survey he thought he knew why!

Regarding the absence of any good results from the 10 to 11-year-olds and the difference between 12, 13, and 14 year groups he thought these were all a reflection on the small size of the groups involved. With so many variables to be considered, and so many factors to influence the final result it was not surprising there was no greater conformity in groups this size.

He had no details of the complexity of lower arch treatment. He had found it difficult enough discovering how many appliances were used and for how long. There was no record of the length of appointments.

With regard to initially rotated third molars there were some cases where the occlusal surface was visible on early radiographs, presumably facing lingually. Subsequent radiographs showed a more normal appearance of the developing third molar so there was likelihood of spontaneous improvement from such a position. Few cases had second molar extractions so early that one could say whether this was a possible cause for the poor results among the early extraction cases.

Mr. E. K. Breakspear said that it was his experience that, in the great majority of cases, the path of eruption remained constant unless something happened to change it. If one projected the position of the tooth in the direction in which it was facing to see where it would emerge, in the case shown on the left side in Fig. 8, it would have been seen that it would cut the first molar—in other words, it would never have got up unless there was a remarkable amount of growth.

He also thought that the cases which had shown great spacing at the end could have been foreseen in a similar manner; but he was glad Mr. Cryer had reminded members that the positions shown were not necessarily the final positions and that changes could take place after the teeth erupted.

He had two questions. He noticed that in at least one case there appeared to be bodily mesial movement of the third molar, which he had seen in two or three cases. It had happened just often enough to make him frightened of it, and therefore he liked to have a little spare space just in case that happened. He wondered whether Mr. Cryer could predict when it would occur. Secondly, he asked if Mr. Cryer would agree that the lower incisor problem was really a problem of maturation of the face at the anterior part of the mouth—not really very much connected with the third molars at all.

Mr. Cryer said that having read Mr. Breakspear's article in the *Dental Practitioner* he had gone back to some of his own cases. He thought that the method of projecting the path of eruption of the third molar as a straight line from its initial position would indicate

as favourable the same cases as his own method of selection based on the present survey. However, he had observed that a number of third molars improved their angulation by becoming more vertical during eruption and not only after making contact with the first molar.

Regarding the relationship between lower incisor crowding and third molar impaction he thought the third molars were unfairly blamed for causing crowding. Really, the third molar eruption was prevented by the same arch shortness which aggravated the lower anterior crowding. He thought that this happened in cases where third molars were absent, and therefore agreed with Mr. Breakspear that this was at least partly a result of maturation. However, the degree of crowding might be influenced by the presence of third molars.

Mr. H. D. Astley-Hope asked if, in the relief of lower overcrowding by extraction of lower second molars, Mr. Cryer made any note of cuspal interlock. His own impression was that, while cuspal interlock would not prevent mesial drift, it seemed to have a considerable inhibiting effect on distal drift of buccal segments when one was extracting from the back.

Mr. Cryer replied that this was not something he had observed in these cases. He thought that from those he had measured subsequently there seemed to be a better chance of increasing lower arch length where posterior extractions were carried out in both arches. This suggested that if upper posterior teeth were moved distally there was a greater likelihood of the same movement occurring in the lower arch.

Mr. R. E. Rix said he thought Mr. Astley-Hope was thinking about Angle's Class II cases where he had taken out the upper first premolars and lower second molars. If the upper first premolars were taken out at 10 and lower second molars at, say, 13 years, and if in the meantime the upper arch is treated, a careful examination of the lower arch shows that $\overline{4|4}$ have risen slightly above normal occlusal level during the three-year interval. An adverse cuspal lock has been created between $\overline{4|4}$ and $\overline{5|5}$ which reduces the benefits to be expected from the extraction of $\overline{7|7}$. Best results are to be obtained if treatment is delayed until upper and lower teeth can be extracted at the same time or at least when only a short interval elapses between the extractions.

Mr. E. S. Broadway asked whether any of the second molars which were removed were impacted, and whether Mr. Cryer had any special note on the fate of the third molars. Had any of the third molar teeth been removed?

Mr. Cryer replied that there had been one case, but it was not in the survey because he had been unable to get the patient back. It was one with initially severe mesial inclination of the lower third molars so he was particularly sorry not to have seen the final result.

Mr. P. R. W. Coyle said that so far, late imbrication of incisors had been associated with maturation changes and eruption of second or third molar teeth, but in a large number of the cases there was lower arch treatment, presumably to make room for the second premolars to erupt. He asked if any precaution was taken to assess whether the lower incisors had been proclined if they were used as part of the anchorage and whether this might have brought on late imbrication.

Mr. Cryer said that the last case he had shown was an example. It was a Class II, division 2 malocclusion

with some lower incisor crowding. Appliance treatment was limited to the upper arch and the one used to retract the premolars and canines carried an anterior bite plane. As a result, there was a temporary improvement of the lower anterior alignment, but after discontinuing appliances the initial degree of incisor crowding returned. A lower appliance used to move the buccal segments distally was likely to procline the lower incisors into an unstable position. In this survey of the 11 cases which showed slight deterioration of lower anterior alignment 7 were treated without the use of lower appliances, 1 required one appliance, and 3 two or more appliances. All wore appliances in the upper arch.

Mr. F. Allan said that in a number of the cases shown, Mr. Cryer had extracted the second molar when the first molar was in need of later conservation treatment and could well have been lost, so that the patient might end up with the third molar in poor position and the lower anteriors crowded because of mechanical locking when, in actual fact, the whole problem could quite easily have been solved by extracting the first molar.

Mr. Cryer replied that he thought the conservative condition of the first permanent molars was one of the most important factors to be taken into account. He hoped he had stressed it sufficiently.

Mr. V. G. Rice asked if, in deciding whether to remove the lower second molars, Mr. Cryer had made any assessment of how difficult he thought the removal of the third molars might be? He thought Mr. Cryer had skated rapidly over the effect and distress caused to the patient in surgical extraction of lower third molars. In practice, one did see a number which were not as successful as the surgeon might think in so far as there were unpleasant sequelae, and he had seen a number of cases in which the lower second molar had also had to be removed.

Mr. Cryer said that at what seemed the optimum time for the second molar extractions only the crowns of the third molars were formed. One could not be sure of the size of the roots. Upper third molar roots were sometimes small. It might be that providing extra space permitted an increase in root size. He had the impression that the lower third molars in this survey had straighter roots than one often saw.

Mr. J. R. Pettman asked Mr. Cryer if he thought the teeth came forward because of 'mesial shift'. The isolation of the third molar was most interesting in this study because it should surely reveal whether this mythical shift was there.

He believed that the third molars came forward mainly because of eruptive forces and their angulation, initially, although in some instances illustrated in the paper, the bodily movement of the teeth seemed to show that there was indeed mesial shift.

Mr. Cryer said when the lower second permanent molars were extracted space was available for the relief of crowding particularly uprighting of a mesially tilted first molar, and the eruption of the third molar. In a number of cases the majority of this space was available for the latter movement. If third molars erupted in a straight line one would expect that those which initially were upright would erupt spaced from the first molar. This did occur, but usually only with late extractions. In cases of early lower second molar extractions the third molars erupted contacting the first molar. He therefore felt that during their eruption mesial bodily movement of the third molars did occur in some cases.

SOME OBSERVATIONS ON CERTAIN DEVELOPMENTAL DENTO-ALVEOLAR ANOMALIES AND THE STIGMATA OF CLEFT

D. B. JOHNSON, B.D.S., F.D.S., D.Orth. R.C.S.

Consultant in Orthodontics, Leeds Regional Hospital Board

THERE are occasional irregularities of maxillary incisors which cannot be explained by the known causes of malocclusion. The object of this communication is to show that some of these may be related to the cleft palate deformity.

Occasional references are made in the literature to the concept that errors in fusion of the embryonic processes may, in the absence of a cleft, leave an imprint in the hard and soft tissues derived from the primitive palate (Foch-Anderson, 1942; Bohn, 1963; Vondra, 1957). Various terms have been used to describe this idea: 'formes frustes', 'microform of cleft' (Mengele, 1939), 'submucous clefts', 'concealed clefts' (Broderick, 1935; Vondra, 1957), 'minimal clefts' (Brown, 1964). Dixon (1963) suggests the term 'stigma of cleft', referring to the signs associated with clefts.

Recent advances in the embryological field and a better appreciation of the true nature of clefts now make it worth reconsidering this concept. In addition, further classification and rationalization of the dental anomalies associated with clefts give a yardstick by which to assess the similarity of dental malformations seen in the absence of clefts.

The disorder of cleft palate has been established as a developmental aberration. The exact aetiology is obscure, but it is thought to be a combination of hereditary and environmental influences. Carter (1964) has suggested that the genetic factor is a susceptibility of the embryo to intra-uterine disturbances.

In general, developmental disorders may be expressed in varying degrees in the postembryonic stages due to variation in the manifestation of the particular gene together with the other genetic and non-genetic factors concerned. The spectrum of the abnormality may range from an extension of a normal variation to a gross deformity. Frequently, individuals who must have transmitted the trait may have no external manifesta-

tions, but a biochemical or microscopic test may reveal subclinical abnormality.

Hereditary predisposition, however, is not necessarily a prerequisite for the production of the phenotype for a mutant gene and the whole range of an abnormality may be seen in the absence of a family history.

If a complete morphological series can be constructed showing transition from one stage to the next, continuity is established and the variants may be regarded as being part of the same entity, differing only in degree.

A number of genetic studies have been carried out in an attempt to show evidence of hereditary transmission of the cleft palate in the form of microform or minimal clefts (Mengele, 1939; Fukuhara and Saito, 1963; Fukuhara, 1965), and in particular dental anomalies have been included in this category.

The initial development of the dental lamina in the premaxillary area was reported by Tonge (1960) who demonstrated odontogenic epithelium coincident with the formation of the primary palate. The formation of a tooth germ resulted from the activity of several growth centres. Politzer and Weizenberg (1954) showed that the lateral incisor in particular develops in relation to the fissural area. Glasstone (1952) has shown that once a tooth germ reaches a certain stage, development follows a predetermined course. If, therefore, a developmental disturbance occurs affecting the dental lamina an irreversible change will take place and permanently influence the form of the teeth.

Studies of the dental anomalies seen in patients with clefts have shown that cleft formation influences the dental lamina at a susceptible stage, affecting not only the deciduous teeth but also their permanent successors and, in addition that these anomalies may be the most sensitive indicators of relatively minor disturbances.

Presented at the meeting held on 9 January, 1967.

EMBRYOLOGY

The classic view of His and others was that a cleft arises because fusion of the various processes forming the facial complex does not occur. However, according to modern theory the so-called 'processes' are in fact growth centres of mesoderm divided by depressions of the surface, the final shape of the face being formed by the filling in or 'merging' of these depressions and therefore the epithelium does not initially divide the processes.

mesenchyme above the primitive oral cavity, and normally disintegrates, but remnants of it are found at the sites of fusion.

The Pathogenesis of Clefts of the Primary Palate

Studies of embryos with clefts by Stark (1954), Tondury (1961), and others have shown that the primary defect is due to failure of growth of mesenchyme and the process of mesenchymal infiltration through the epithelial wall, although Warbrick (1960) put forward the view that in addition to mesenchymal deficiency there is an

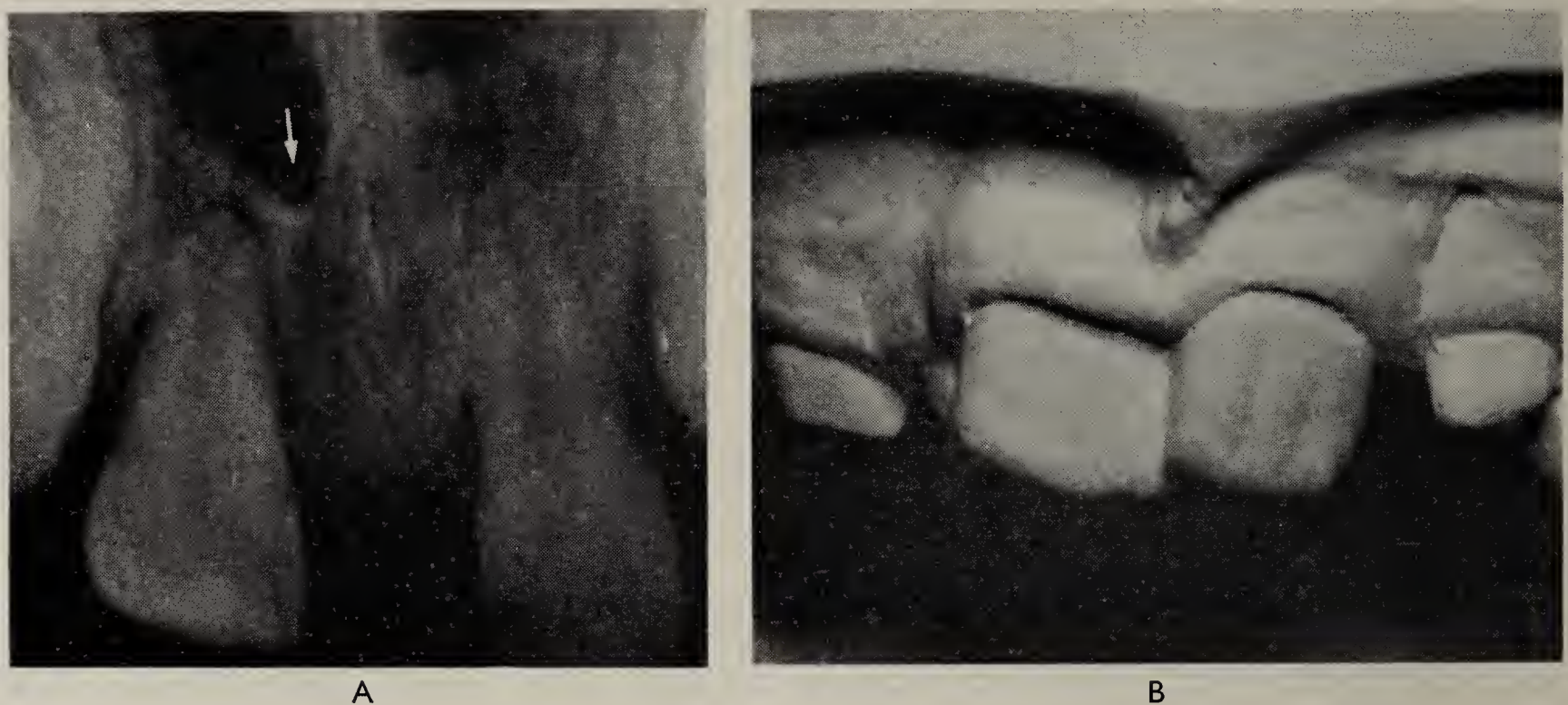


Fig. 1.—Microforms associated with lip clefts. A, Intra-oral radiograph of patient with unilateral lip cleft on right side showing defect in nasal floor. B, Model of patient with bilateral lip cleft and cleft palate with alveolar defects.

In man, the development of the nasal cavity begins with two ectodermal placodes on the surface of the frontonasal process. By differential growth these are converted into grooves with a raised rim formed by the medial and lateral nasal processes. The rim is deficient caudally, and its circumference is completed by growth of the maxillary process across the caudal perimeter (Warbrick, 1960).

Thus, an epithelial wall is present between the medial and lateral nasal processes for a few days during the formation of the primordium of the nasal cavity. It appears as a groove on the surface (primitive palatine groove), connecting the nasal pits to the stomatodeum. Subsequently, this epithelial wall is invaded by mesenchyme, and it disintegrates, beginning at the most caudal end (Tondury, 1961).

During this phase of development the primitive nares are formed by epithelial proliferation ventrally into the underlying mesenchyme. As a result of this, cavitation occurs and the grooves are converted into pits, which deepen to form the nasal cavity. This proliferating epithelium, the so-called epithelial fin, extends into the

extension of the normal process of cavitation of the epithelial fin. There is no specific stage at which arrest of development may occur and abnormal development may be manifest in more than one way as evidenced by the presence of epithelial inclusion cysts in the fissural areas (Patten, 1961).

If a relatively minor disturbance occurs then a defect involving mesenchymal but not necessarily epithelial tissue will result corresponding to the submucous cleft of the secondary palate. As yet, a submucous cleft of the primary palate is not an established entity, although one or two cases have been reported recently which approximate to this.

CLEFT MICROFORMS

As clefts involving primary palate differ in their morphological and genetic characteristics from clefts of the secondary palate, that is, the deformity of isolated cleft palate, the remarks in this paper are therefore limited to aspects of clefts of the primary palate.

Foch-Anderson (1942) and others have recorded the great variation in the extent of clefts

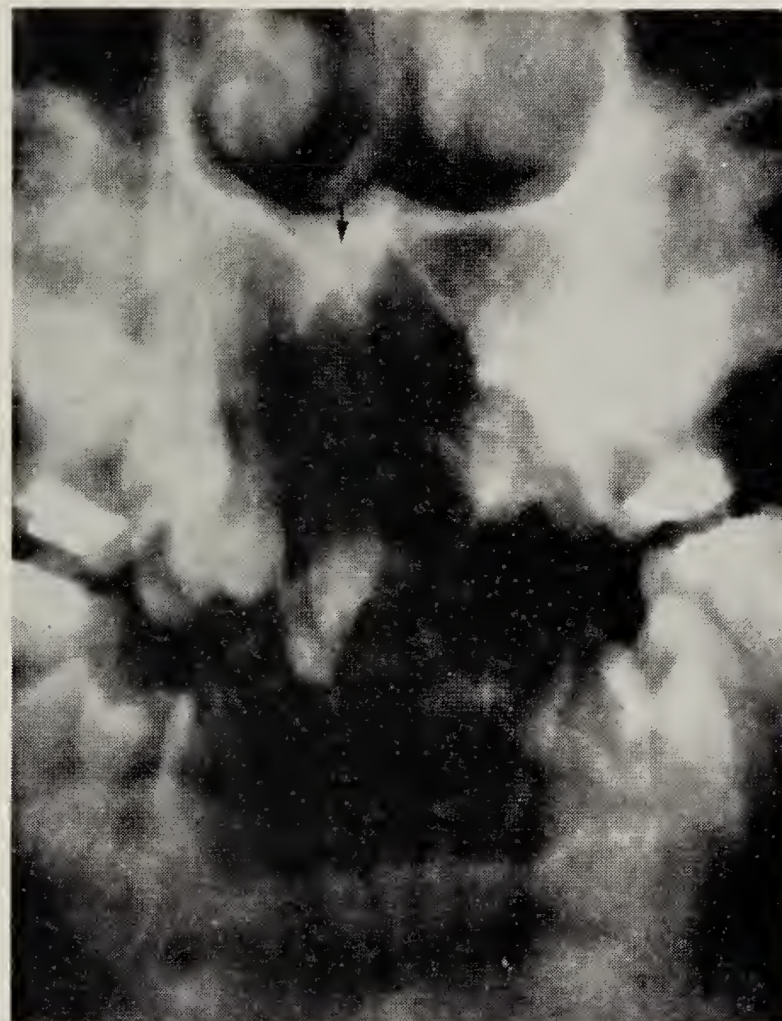
of the primary palate, showing a complete range from a small notch in the vermillion margin to a completely split lip and jaw. Associated with the cleft there is the skeletal deformity, in the form of maxillary retrusion, and nasal deformity, seen as an abnormal nasal aperture on the affected side

1. Microforms associated with Lip Clefts

Broderick (1935) and Bohn (1963) recorded the presence of defects in the nasal floor (*Fig. 1A*). Bohn stated that 'a review of the radiographs reveals that many patients present with a more or less marked bone defect in the anterior part of

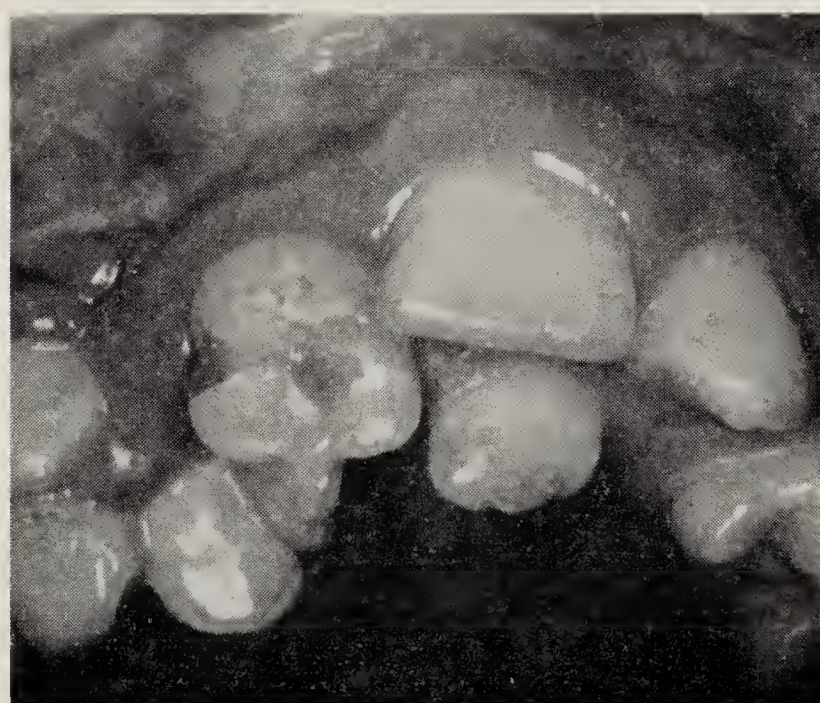


A



B

Fig. 2.—Microforms on the unaffected side in unilateral clefts. A, Occlusal radiograph of patient with complete cleft of lip and palate on right side showing minor defect in the nasal floor on the left side. B, Similar defect seen on postero-anterior radiograph of patient with complete cleft on left side. C, Patient with a complete cleft on right side showing a severe displacement of $\underline{I2}$ with enamel hypoplasia.



C

(in unilateral clefts). These are now thought to be due to failure of maxillary growth as part of the cleft syndrome and not due to the effects of surgical repair, as was once believed (Stenström and Oberg, 1961; Haggerty and Hill, 1964).

In addition, there are signs of disturbances which, although not severe enough to produce a cleft, have altered the form of the tissues in the fissural areas. These are most frequently referred to as microforms of cleft and may be seen not only in the presence of a cleft but also in individuals without a cleft.

In general, these signs occur at three levels of severity:—(1) Submucous defects associated with lip clefts; (2) Defects on the unaffected side, in unilateral clefts; (3) Anomalies in the absence of a cleft.

the floor of the nasal cavity, while the alveolus seems normal. The defect may be interpreted as an enlarged upper part of the incisive canal or as a notch in the lower margin of the nasal incisure (pyriform aperture) or as a combination of the two.'

Alveolar defects have been reported by Foch-Anderson (1942) or Pruzansky (1953) in the form

of small fissures, grooves, or dimples in the surface (*Fig. 1B*).

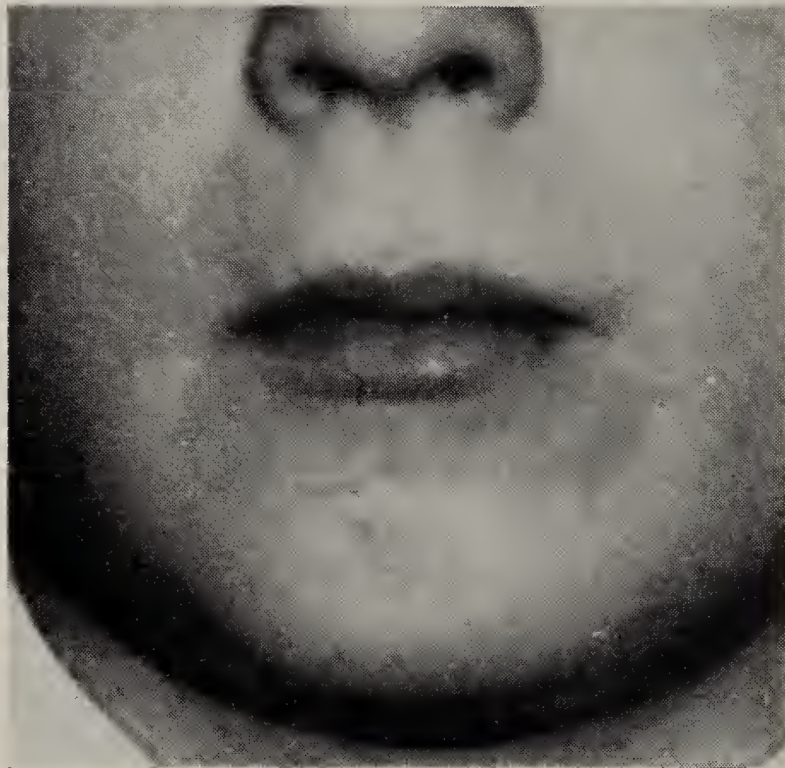
2. Microforms on the Unaffected Side to a Unilateral Cleft

As clefts of the primary palate are bilateral in their manifestations it is assumed that minor

Vonda found manifestations of minor disturbances in 30 per cent of patients with clefts.

3. Microforms of Cleft seen in the Absence of a Cleft

In the light of recent work on the aetiology of clefts it seems logical to anticipate the presence of



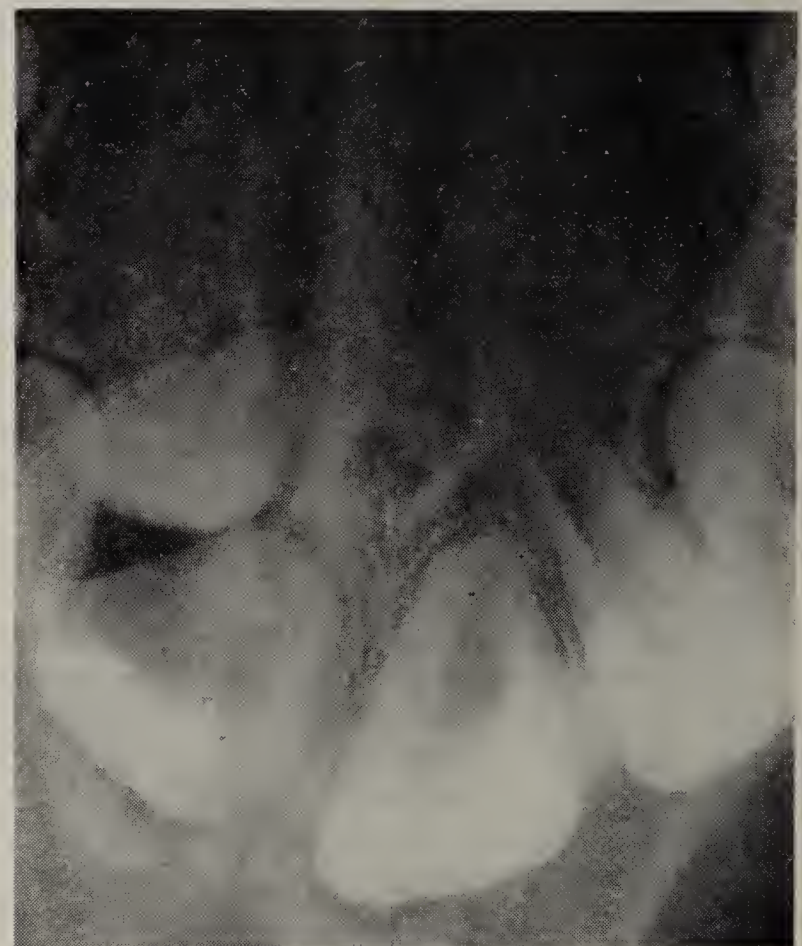
A



B



C



D

Fig. 3.—Case 1. A, Defect on outer aspect of lip. B, Groove in alveolus between C1. C, Occlusal radiograph. D, Vertex occlusal radiograph showing displacement of 2.

forms of cleft will be displayed on the opposite side to a unilateral cleft (*Fig. 2*). The presence of cleft-like anomalies on the unaffected side is reported by Vondra (1957) and Dixon (1966b).

a number of intermediary forms between normality and an established cleft.

The presence of the nasal deformity in the absence of a cleft has recently been reported by

Brown (1964) and Stenström and Thilander (1965); the so-called 'cleft-lip-nose anomaly' in which the nasal deformity is seen in the absence of a cleft. Hopkin (1963) reported a severe type of Angle's Class III malocclusion displaying maxillary retrusion, absence of the anterior nasal spine, and deficiency of labial bone over the maxillary incisors which he explained on the basis of a minor disturbance in fusion.

Evidence of hereditary transmission of cleft lip and palate was shown by Fukuhara and Saito (1963), and Fukuhara (1965). Using frontal laminagrams they demonstrated defects in the nasal floor in a high proportion of the parents and siblings of patients with clefts. Dixon (1966a) reported an increased incidence of prenatality in the families of patients with clefts.

Dental Microforms of Cleft

Studies by Bohn (1963), Dixon (1963), and recently by Kraus, Jordan, and Neptune (1966) have shown that the dental anomalies seen in patients with clefts fall into a particular pattern, and that very similar dental anomalies are seen in the absence of clefts being generally regarded as a minor form of the same disorder, known as dental microforms.

The most frequent anomalies in patients with clefts are absent teeth and supernumerary teeth. Absence of maxillary incisors and premolars are found, especially in clefts involving the alveolus and hard palate, whilst supernumerary teeth occur in the lateral incisor area and are seen most frequently in less severe clefts. The supernumerary teeth have the general form of a lateral incisor, although there is a tendency for the tooth in the mesial segment to resemble a central incisor and that in the distal a canine. The central incisor on the affected side in unilateral clefts is usually smaller with deformed crown and root. Hypoplasia of a chronological type has been shown to affect the deciduous and permanent incisors and molars (Mink, 1959). This has been attributed to the effects of surgical repair.

Very similar dental anomalies are seen in lip clefts and, in addition, the lateral or central incisor may be rotated or displaced (Pruzansky, 1953; Foster, 1966). Bohn (1963) observed the whole range of the dental anomalies on the unaffected side in unilateral clefts (*Fig. 2C*) and showed that the size of the lateral incisor on the unaffected side is to some extent dependant on the dental anomaly on the affected side, i.e., if the affected lateral is absent the corresponding tooth on the normal side is absent or small. Similarly, if supernumerary teeth are present on the cleft side the lateral on the normal side is larger than average.

Kraus and others (1966) in a study of foetal material showed that the dental malformations seen in the cleft material are occasionally seen in foetuses without clefts, although the number and

severity in these cases are much reduced. Bohn (1963) mentioned a number of reported cases of supernumerary teeth identical in form to those seen in cleft patients. He concluded that supernumerary centrals, laterals, or canines are caused by the same factors as cleft palate.

Several attempts have been made in the literature to show that dental anomalies are evidence of genetic transmission of cleft palate. Lucas (1888) reported an increased incidence of absent lateral incisors in the families of cleft patients. Dixon (1963) also showed an incidence of absent premolars in these families. He explained this on the basis of an associated genetic anomaly of anodontia.

To summarize therefore; clefts of the primary palate show a complete range in their extent. Associated with the cleft there are signs of a disturbance at the sites of fusion not caused by the cleft. The cleft is therefore a symptom of a disorder affecting the whole process of development of the fissural areas and particularly the dental lamina. The presence or absence of a cleft is not the sole criterion for concluding that an error in fusion has taken place.

Cosman and Crikelair (1965) predicted that a submucous cleft of the primary palate might have the following characteristics: 'Such a defect might have the appearance of a very incomplete cleft of the lip with notching of the alveolus, attenuation of the nostril floor, and spreading of the ala. Radiographs would show a local dental deformity in the arch and the bony deficiency involving the alveolus and palate extending to the incisive foramen.'

The following cases are reported which conform to the theoretical requirements:—

Case 1

This patient was originally referred for consultation regarding his incisor irregularity. Radiographs showed 2 severely displaced. Further examination revealed signs of a developmental disturbance in this area.

LIP

A linear mark was found on the outer aspect of the upper lip on the right side running vertically 3–4 mm. above the red margin (*Fig. 3A*). There was accentuated contour of the lip on this side with a deficiency of tissue on its inner aspect extending to the sulcus. The mucous membrane in this area was paler in colour.

ALVEOLAR SIGNS

A vertical groove was present in the alveolus which ran from the sulcus to the gingival margin terminating inferiorly in a deep fissure (*Fig. 3B*). The vertex occlusal radiograph showed a radiolucency between C1 (*Fig. 3D*).

TEETH

The root development of 2 was severely retarded and the tooth itself showed a severe bodily displacement in a palatal direction (*Fig. 3C*). There was a

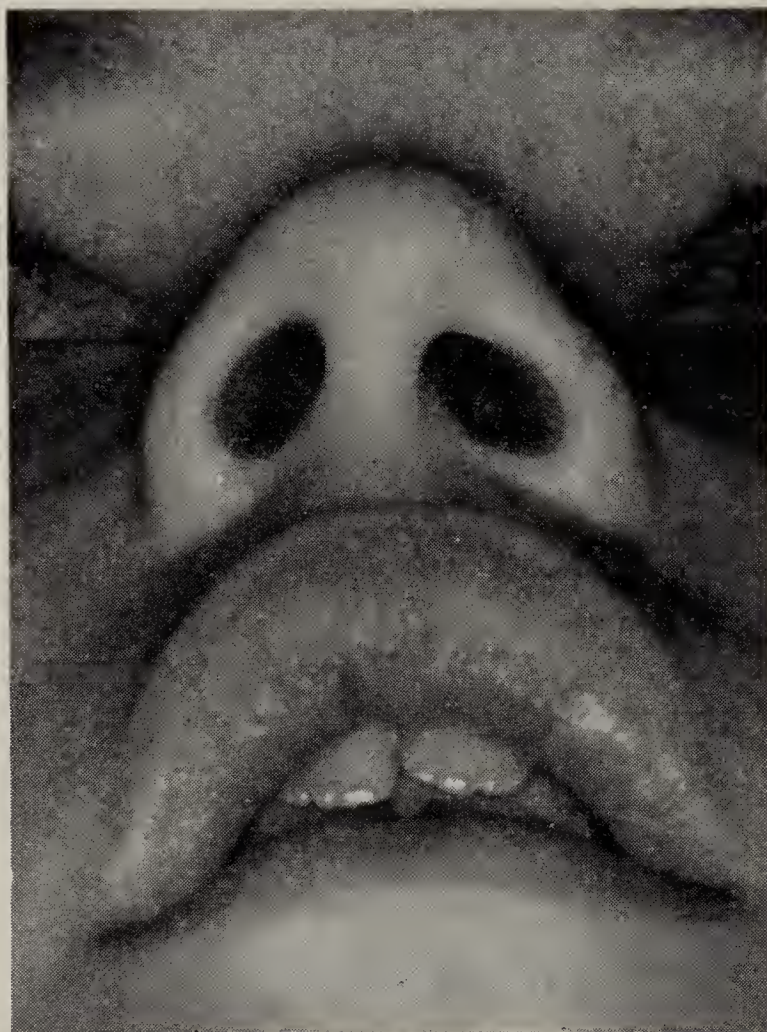
marked asymmetry in the size of the crowns of $\overline{111}$ and an accentuated labio-lingual curvature on $\overline{11}$ which had a dilacerated and shortened root.

Case 2

This patient presented during a routine examination with a rotated and displaced $\overline{12}$. Further examination showed a marked nasal asymmetry.

NASAL SIGNS

There was an abnormal nasal aperture on the left side with increase in the width of the nostril base and depression of the ala cartilage (*Fig. 4A*). Clinically,



A

over the central incisor was confirmed by a postero-anterior radiograph showing a break in the radio-opaque line forming the anterior nasal aperture and a radiolucency in this area (*Fig. 5C*).

DENTAL SIGNS

There was a supernumerary tooth distal to $\overline{21}$ (*Fig. 5D*). Although conical in form, it had the characteristic cervical contour of the enamel (*Fig. 5E*). The form of this tooth resembled those seen in the distal segment of an alveolar cleft. $\overline{21}$ was larger than on the unaffected side and showed a resemblance to the central incisors and was completely rotated with its labial surface facing lingually (*Fig. 5A*).

The central incisors showed asymmetry, that of the affected side being smaller.

Case 4

This patient first attended on 12.2.60. The original notes state, 'Angle's Class III malocclusion on a severe Skeletal III base with overclosure and increased inter-occlusal clearance. The patient is unable to



B

Fig. 4.—Case 2. A, Cleft lip nose. B, Rotation of $\overline{12}$ with hypoplastic $\overline{1D}$.

this was very similar to the cleft-lip-nose anomaly, as described by Brown (1964) and others.

DENTAL SIGNS

Although there were no radiological signs present $\overline{12}$ is rotated and its apex displaced distally (*Fig. 4B*). $\overline{1CD}$ had hypoplastic areas affecting the tips of the cusps, in contrast to \overline{DCI} .

Case 3

This patient was referred by his dental practitioner for advice regarding his rotated $\overline{21}$. Radiographs showed a supernumerary tooth distal to $\overline{21}$.

The stigmata of cleft in this case were:—

NASAL SIGNS

Nasal asymmetry with an increase in the width of the nostril base on the affected side and deviation of the tip of the nose (*Fig. 5B*). There was a palpable thinning of the musculature of the lip below this. Intra-oral radiographs showed a small radiolucency over the apex of $\overline{11}$. The presence of a bony defect

occlude with an edge-to-edge incisor relationship. $\overline{15}$ is absent and $\overline{12}$ displaced labially'. The incisor relationship was corrected and attempts were made to correct the irregularity of $\overline{12}$, but these were not successful. In December, 1965, treatment was considered complete and the patient about to be discharged when it was noted that a vertical fissure with depression of the surface contour was present in the attached gingivae between $\overline{112}$. Examination of the models showed that this had been present either as a groove in the surface of the alveolus or as a gingival fissure since the patient first attended.

The following signs indicated that this was a mild form of alveolar cleft:—

SKELETAL MORPHOLOGY

The initial lateral skull radiograph on tracing showed a marked skeletal prenormality with an SNA-SNB difference of -4° , and after the correction of the incisor relationship a difference of -1° . The SNA value of 77° confirmed the clinical impression of maxillary retrusion.

ALVEOLAR SIGNS

There was a small fissure in the gingival margin about 2-3 mm. in depth. This extended into the interdental space between the $\underline{12}$ and was present on the surface of the palatal mucosa as a slight surface marking (*Fig. 6A*). Superiorly, the fissure terminated in a small depression on the surface of the alveolus which continued to labial vestibule.

NASAL SIGNS

The left nostril was slightly wider than the right. The occlusal radiograph showed a radiolucency in the nasal floor in the region of the incisive foramen and extending forwards from this. There was a slight break in the bracket-shaped line which forms the anterior border of the nasal cavity (*Fig. 6B*). The final lateral skull radiograph showed a V-shaped defect in the anterior part of the nasal floor above the central incisor.

DENTAL SIGNS

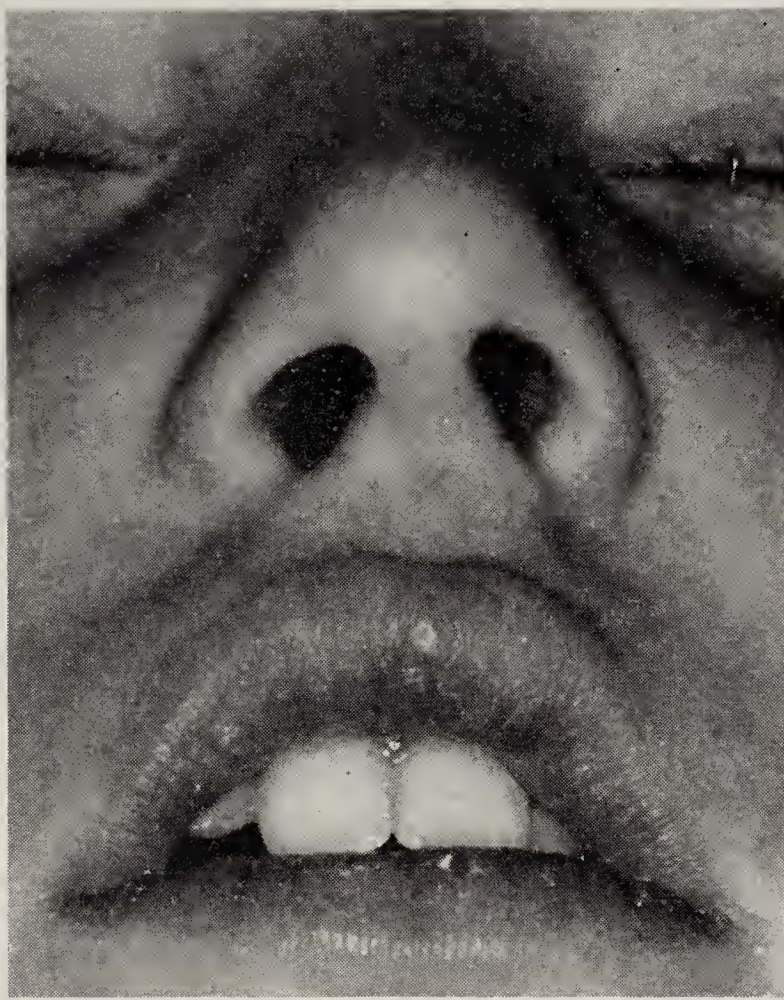
$\underline{12}$ was rotated, and its apex was distally displaced. $\underline{11}$ was smaller than $\underline{1}$ and its root length shorter. $\underline{5}$ was absent. There were hypoplastic rings seen both clinically and radiologically affecting the $\underline{112}$ although there was no history of trauma affecting these teeth.

DISCUSSION

A parallel can be drawn between minimal clefts of the primary palate and the well-established



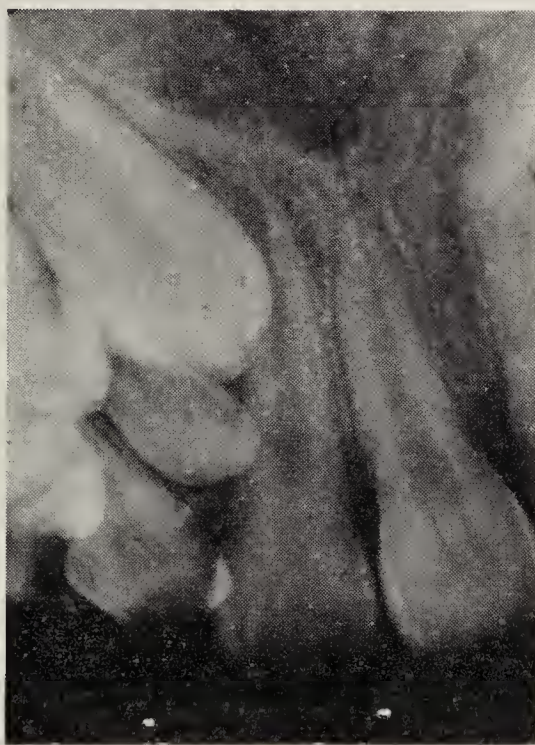
A



B



C



D



E

Fig. 5.—Case 3. A, Severe rotation of $\underline{21}$. B, Nasal deformity with increase in width of nostril base on the right side. C, Postero-anterior radiograph showing defect in nasal floor above $\underline{11}$. D, Radiograph of $\underline{211}$ showing supernumerary tooth distal to $\underline{21}$. E, Extracted $\underline{21}$ and supernumerary (mesial aspect).

entity of the submucous cleft of the secondary palate.

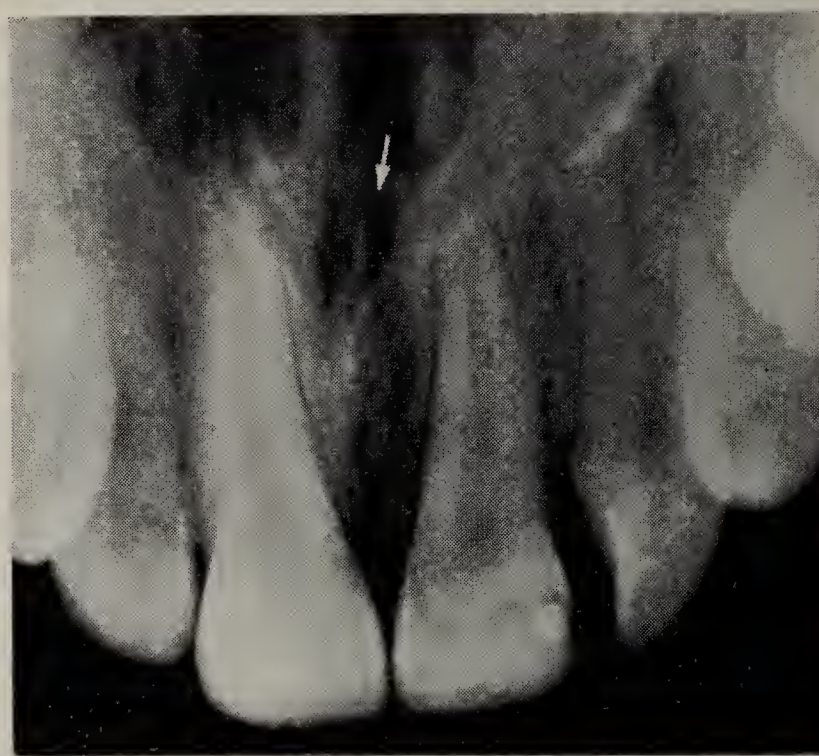
Both involve defects in tissues of mesenchymal origin with little or no implication of epithelial tissue, although an exact analogy is not possible due to the different nature of the primary and secondary palate.

Recent embryological work placed more stress upon the development of the nasal cavity in the

(1961) frequently preceded by deciduous supernumerary teeth, indicating that these are derived from odontogenic epithelium with specific morphogenetic properties. The view has been put forward that a normal lateral incisor is originated from two growth centres, one derived from the frontonasal process and the other from the maxillary process. A transient delay in the dissolution of the epithelial wall will give an



A



B

Fig. 6.— Case 4. A, Alveolar defect is seen as groove between |12 and rotation of |2. B, Occlusal radiograph showing defect in nasal floor and hypoplasia of |12.

aetiology of clefts of the primary palate. The view that the mesenchymal defect arises during the formation of the nasal cavity is supported by the case reports of the cleft-lip-nose anomaly and the observation of minor defects in the nasal cavity of the unaffected side in unilateral clefts. In addition, the geometric analysis of tissue deficiencies in lip clefts by Cosman and Crikelair (1965) showed a deficiency at the nostril base and not at the red margin of the lip. It may be that cleft formation will only result when there is a relatively large mesenchymal deficiency in this area.

The relatively inaccurate methods of radiography make analysis difficult, and overlapping bone may hide a minor defect.

Supernumerary Teeth

There are reasons for suggesting that supernumerary teeth in the lateral incisor area differ in their mode of formation from the more common midline supernumerary.

Bohn (1963) makes several generalizations about these teeth in patients with clefts; notably that if the cleft is less severe the supernumerary teeth are longer and more of an incisor form. The incisor form of supernumerary teeth in the lateral incisor area in normal individuals has also been noted by Staphne (1931) and Gardiner

(1961) frequently preceded by deciduous supernumerary teeth, indicating that these are derived from odontogenic epithelium with specific morphogenetic properties.

The presence of severe displacements and rotations in association with supernumerary teeth has been noted. It is, however, possible that these irregularities may be a manifestation of a more general disturbance and not the direct effect of the presence of a supernumerary tooth.

Enamel Hypoplasia

The association of enamel hypoplasia with the dental stigmata of cleft is observed. It is worth mentioning that enamel hypoplasia has been associated with other developmental disturbances, particularly by Grahnen and Larsen (1958) who showed a similar but symmetrical pattern in patients with a history of prematurity.

In cleft cases and in cleft microforms the hypoplasia is usually localized to the area of the disturbance.

The explanation given by Grahnen and Larsen of an increased cellular susceptibility of certain enamel-forming areas to environmental disturbances may account for the pattern of hypoplasia in these patients.

Incisor Irregularities

It is submitted that there may be occasional cases of incisor rotations or displacements which are

caused by a minor cleft form. The prognosis for correction of such irregularities, because of the deficiency of bone in the area, would seem to be less favourable than similar variants which are attributable to other causes, such as crowding.

SUMMARY AND CONCLUSIONS

The literature relevant to minor forms of cleft has been reviewed. Four cases with dental anomalies similar to those seen in lip and alveolar clefts are reported. Associated with these dental irregularities it was noted that there were minor defects in the lip, nasal cavity, and alveolus. As similar defects have been shown to occur associated with clefts and in the families of patients with clefts it is concluded that these dental anomalies may be caused by the same process, which, in an extreme form, causes the disorder of cleft lip and palate.

This explanation may account for some of admittedly rare but still appreciable incisor irregularities, which are not explicable in terms of the present concepts of the aetiology of malocclusion.

Acknowledgements

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DISCUSSION

Mr. G. Wreaks asked if Mr. Johnson's attention had been drawn to these cases by a family history of cleft, or was there any genetic suggestion. With regard to the second case where the lateral was completely rotated through 180°, the only time he had seen this identical dental appearance it had been associated with a definite hare lip; the alveolus in this case also being apparently intact.

Mr. F. Allan asked if there was any contra-indication to movement of these teeth because of the clefts.

Mr. L. A. Usiskin asked if Mr. Johnson was suggesting that, in cases where notching occurred on the alveolus and there was rotation of the incisors, yet the amount of bone appeared to be quite normal on X-rays, rotation or over-rotation was as difficult as in true cleft cases.

Mr. Johnson, in reply to Mr. Wreaks, said that he had only one case in which a history of clefts was found. The patient had a supplemental incisor and what appeared to be a small defect in the nasal floor. There was a history of isolated cleft palate over two or three generations which was known to be genetically independent of clefts of the primary palate, so there was not a very good case here. This case showed a developmental anomaly in the lateral incisors in other members of the same family. This was more common.

In reply to Mr. Allan, he said it was known that the severe irregularities which were seen in association with clefts were much more liable to relapse. This had been thought to be due to deficiency of bone in the area. Some of the micro-forms he had corrected had relapsed quite badly, and occasionally showed resorption of the root.

RESORPTION OF THE ROOTS OF UPPER INCISOR TEETH DUE TO MISPLACED CANINE TEETH

P. I. TOWNEND, B.Ch.D., F.D.S., D.Orth. R.C.S. (Eng.) *

Lecturer in Children's Dentistry and Orthodontics, Birmingham Dental School

INTRODUCTION

ALTHOUGH upper canine teeth are frequently misplaced, they rarely cause damage to the incisor teeth against which they might be impacted. Hitchin in 1956 reported that of 109 impacted canine teeth, only 5 had caused resorption of the incisor teeth, although as he points out, many patients with resorption of incisors and

upper left lateral, and partial resorption of the left central incisor, although resorption of this particular tooth appears to have stopped. The third one, a more complex case, shows resorption of the roots of both central incisors by the maxillary canine teeth, which are mesially inclined. The patient had congenitally missing lateral incisors.

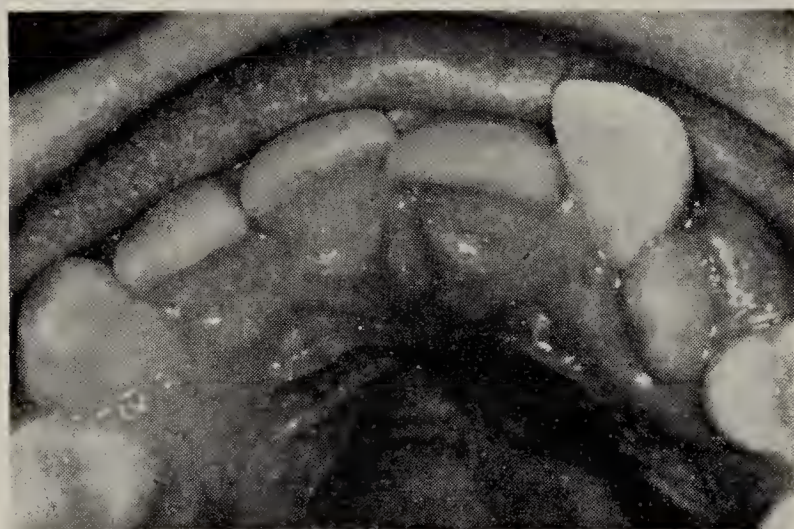


Fig. 1.—First case showing displaced I₂ and erupting I₃.

eventual eruption of the canine teeth do not appear at a hospital as the process is relatively symptomless. Broadway, in 1961, reported to this Society the case of a patient aged 27 years where resorption of incisor teeth had stopped after half of the root had been resorbed.

This is a report of three cases of resorption of the roots of incisor teeth. Each year, nearly 1000 new orthodontic cases are examined in the Orthodontic Department of the Birmingham Dental Hospital, and over the last three years only three examples of this condition have appeared. It is therefore of rare occurrence.

Of these three patients, one shows complete resorption of the upper left lateral incisor, and the second shows complete resorption of the



Fig. 2.—Radiograph of first case, showing resorbed lateral incisor.

CASE REPORTS

Case 1

The first patient to be described in detail is aged 16 years and was referred to the department by her dentist because I₂ was proclined. On examination, it was found that I₂ was proclined and that I₃ was

*Present address: Dental Department, City General Hospital, Carlisle, Cumberland.

erupting immediately on the palatal side (*Fig. 1*) of the lateral. The lateral tooth was not mobile and showed a normal response to the electric pulp-vitality tester. All other teeth in the mouth were in a normal position, third molars being impacted. The canine space had become reduced by about 3 mm. due to mesial drift of the upper left buccal segment.

Radiography (*Fig. 2*) showed that the root of the lateral was completely resorbed, and therefore it was decided to remove this tooth. The pathology report

left central had occurred, presumably when the path of eruption of the canine was adjacent to the apex of this tooth. Treatment for this girl consisted of removing the remains of $\underline{12}$. As no further eruption of the canine tooth took place, it was widely exposed and is now coming down into the arch. It is anticipated that the tip of this tooth will be ground down to more nearly resemble a lateral. The pathology report again was that the lateral showed normal pulp tissue with evidence of repair by cementum.



Fig. 3.—Radiograph of second case showing resorbed apex of central incisor and resorbed root of lateral incisor.

of the lateral stated that it contained normal pulp tissue and that the resorbed surface showed evidence of repair by cementum.

The further treatment of this patient was to guide the erupting canine into a more useful position, and it was subsequently crowned to resemble a lateral incisor.

Case 2

This case is very similar to *Case 1*, $\underline{12}$ being resorbed. This time the patient, a girl of 14 years, was complaining of pain in the anterior part of the upper and lower left quadrants. This was mild and was of one year's duration. On examination it was noted that both upper canine teeth were missing from the arch, but the history revealed that $\underline{31}$ had been extracted because it was erupting on the buccal side of the arch. The space which both upper canines would normally occupy was completely closed, due to mesial drift of both upper buccal segments. The only other clinical sign was that $\underline{12}$ was inclined distally and was also slightly mobile. It showed a normal vitality response. Radiograph (*Fig. 3*) showed that the root of $\underline{12}$ was completely resorbed and that $\underline{13}$ was erupting into the position of $\underline{12}$. Also, some resorption of the upper



Fig. 4.—Radiograph of third case showing resorption of roots of upper central incisors. $\frac{212}{111}$ congenitally absent.

Case 3

This patient, a girl aged 11 years, has more unusual and interesting features. Her medical background is that she has an ectodermal dysplasia showing:—

1. Chronic rhinitis due to congenital developmental defect of the nose.
2. Difficulty in speaking.
3. Mild, but persistent eczema.
4. Partial anodontia: $\frac{5212}{111}$ being missing.

The family history is that the patient's brother, her father, and paternal grandfather all have a history of missing teeth.

On clinical examination, the upper permanent central incisors were found to be mobile and the upper canine teeth were missing from the arch.

$\underline{11}$ gave a positive response to the electric pulp tester, but $\underline{11}$ gave no response. Radiography (*Fig. 4*) showed that $\underline{313}$ were erupting downwards but mesial to their normal position. They had caused almost

complete resorption of the roots of both central incisors.

The treatment plan here was to extract 11, but before this could be done 11 was spontaneously exfoliated. 11 was extracted and the canine teeth eventually erupted. They were then retracted back into their normal position and a partial upper denture was fitted carrying 21112.

DISCUSSION

There are many interesting points arising from this condition. First, why should some misplaced canine teeth cause resorption while others which appear equally or even more closely related to the roots of the incisor teeth, do not? One patient who has been carefully observed for the past two and a half years, has the upper right canine horizontally impacted with crown very near to the apex of the lateral tooth, but without causing any resorption of this tooth. One possibility is that this canine is horizontal and static, while those which have caused resorption have been more or less inclined vertically and mesially, and still have retained their eruptive powers.

DISCUSSION

Mr. F. Allan said he was afraid that there was something wrong with the statistics because everyone knew, including himself, that there were far more cases of resorption than had been mentioned.

The President asked if these cases were symptom-free or was there any pain?

Mr. Townend replied that only the second case he had described had suffered slight pain. The other two had been pain free, but had noticed loosening and displacement of the teeth.

Mr. E. S. Broadway asked Mr. Townend if he discovered a canine resorbing a lateral, or a lateral and central incisor, what advice did he give to the patient? Did he advise them to have the canine removed or to leave it alone until either the central or lateral incisor pulps were exposed and the teeth were causing pain?

Mr. Townend replied that it depended how much resorption of the incisors had occurred. Each case had to be treated on its own merits.

Mr. D. G. Huggins said that he had a case where the canine had resorbed the apical third of the root and he advised the patient to have the canine removed, to have the lateral incisor root-filled, and an apicectomy carried out. Was this a reasonable thing to do in Mr. Townend's view?

Mr. Townend replied that again it depended on the extent of the resorption.

Mr. D. A. Dixon said that he had a case in which a canine was resorbing the lateral fairly substantially. The canine was removed surgically and resorption after two years had remained static, the tooth apparently vital. He therefore did not think that it always needed to be root-filled.

Mr. A. C. Campbell said that he found Mr. Townend's suggestion interesting that migration of

Secondly, although the roots of these teeth were almost completely resorbed, the teeth remained vital. This is not perhaps what one would expect, because resorption at the apex would interfere with the blood- and nerve-supply to the tooth.

A third suggestion is that the canine tooth is not the cause of the resorption, but that idiopathic resorption of the lateral occurs, and this allows the canine to drift mesially and erupt into the position of the lateral. This theory might be tenable for the first two cases which I have presented, but certainly not for the third case.

Acknowledgement

I would like to thank Mr. T. D. Foster, Senior Lecturer in Children's Dentistry and Orthodontics for permission to publish the details of the third patient described.

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the canine should follow resorption of the incisor—rather than the other way round.

He thought that it was the second case shown by Mr. Townend in which the central incisor seemed to have a very flat 'resorbed-looking' apex, as well as the involvement of the lateral.

He asked if Mr. Townend had been able to determine any other possible cause for root resorption in this case.

Mr. Townend replied that there was no other cause at all.

Mr. G. C. Dickson referred to Mr. Townend's suggestion that it was pressure which caused resorption and that without pressure this did not take place, but he did not think it was quite as clear cut as that. Everyone saw cases in which lateral incisors were tilting as a result of pressure from the canines.

He could recall one case in which the lateral incisor had performed some rather extraordinary acrobatics under pressure from the canine. The tooth was lying horizontally with its crown pointing directly forward and the apex palpable in the palate and, in fact, it was being pushed sideways towards the occlusal plane by pressure of the canine. This was an extreme case, but large numbers had displaced teeth caused by pressure from the erupting canine.

He supposed the evidence was circumstantial, but it would seem that only in the odd case was the canine causing resorption of the lateral incisor. He thought that pressure at the apex before the root had completed formation might be responsible for the commencement of resorption.

Mr. Townend said that this was one of the things that he could not explain. The ones that had caused resorption appeared to be more vertical and to still

be erupting while in those which became static, as they sometimes did, the resorption appeared either not to occur or to stop.

Mr. H. Lester said that no one had yet talked about moving the canine into the arch. All the canines that had been reported had been removed. He wondered if it was only in the cases in which there was gross displacement that resorption occurred.

Professor C. F. Ballard said that he wished to support the idea that there might be something idiopathic about resorption. First, he did not think that one could tell where the canine was in relation to anything from an intra-oral film. He could produce evidence that this could not be done. He had intra-oral films which made people say that the canine was in a certain place and he could show them a lateral skull radiograph and prove that it was not and was at right-angles to where they said it was. But with this resorption, he thought that not only the central had a blunted apex but the first premolar as well, and if radiographs were done all round the mouth in this case, he thought it likely that one would find several

apices were blunted, not in relation to any pressure at all. This was what he found in a lot of these cases.

Mr. Townend said that for the last patient, he had taken relevant radiographs to accurately locate the canine tooth, but for the purpose of illustrating the point, he had put in only the one slide. The point about idiopathic resorption was interesting.

Mr. F. L. Coker said that he had looked at an occlusal X-ray last week and found to his surprise that the lateral had been resorbed in the apical third. There was a crescent-shaped indentation at the apex. The first premolars had been extracted about a year previously and it seemed to him that the canine had thus been freed from the impaction. Listening to Professor Ballard he wondered whether this was true. He wondered whether Mr. Townend thought he should expose the canine.

Mr. Townend said he did not think that teeth impacted against the incisors caused resorption, but those very close, and still erupting. If canine teeth move away and appear to be erupting, then he would leave them.

OBSERVATIONS ON THE HISTOLOGY AND HISTOCHEMISTRY OF GROWTH CARTILAGES IN YOUNG RATS

OLLI RÖNNING, L. Odont.

KALEVI KOSKI, L. Odont., D.Odont.

University of Turku, Finland

THE growth-promoting potentials of different so-called growth cartilages have been found to vary quite markedly under non-functional conditions. Thus, for example, the distal, cartilaginous end of the radius of a young rat grows to a considerable extent when transplanted

The present study is an attempt to compare some histological and histochemical aspects between cartilaginous unossified parts of bones from rats of the same age as those used in the transplantation studies mentioned.

MATERIAL AND METHODS

From non-inbred Long-Evans strain rats, five days of age, with no sex-discrimination, the mandibular condyle, the cranial base synchondroses, and some long bones were removed immediately after decapitation. A routine histological processing of one part of the samples was carried out complemented with a combined haematoxylin-alcian blue-van Gieson staining, with alcian blue staining for acid mucopolysaccharides; the PAS reaction was employed for demonstrating carbohydrates with diastase control for glycogen. One part of the samples, together with some structures for reference from slightly older rats, was processed for staining with sudan black demonstrating the calcification front.

RESULTS

The cartilaginous structures presented generally known typical features (*Fig. 1*). Secondary ossification centres were not found in any of the long bone ends. The growth apparatus appeared to be functioning; generally, the row cells formed columns of 20 or more cells, and the hypertrophic and degenerative cell columns were from 4 to 8 cells high.

The structures of the cranial synchondroses and of the long bone cartilages were similar as far as the zonal arrangement near the metaphysis was concerned. There were, however, some differences in the amounts of the different cellular components inasmuch as the row cell columns in the synchondroses were from 8 to 10 cells and the hypertrophic and degenerative cell columns from 2 to 5 cells high (*Fig. 2*).



Fig. 1.—The distal end of the tibia from a 5-day-old rat. Note the narrow strip of sudan black staining of the matrix around the degenerative cartilage cells. ($\times 12$.)

into the brain tissue of a litter mate, whereas the growth of mandibular condyle generally is clearly less under the same conditions (Koski and Mäkinen, 1963; Koski and Mason, 1964; Koski and Rönning, 1966).

Presented at the Research Meeting held in Bristol on 13 April, 1967.

The condylar cartilage differed from the other cartilages markedly (*Fig. 3*). Underneath the articular zone, consisting of densely packed, small round cells forming a belt of about 5 to 6 cells wide, was a zone of cells resembling these but having a more ovoid form and being not so densely packed. This zone blended without a



Fig. 2.—The mandibular condyle from a 5-day-old rat. The sudanophilic area is comparatively broad extending through the whole zone of relatively small hypertrophic cells. ($\times 12$.)

clear boundary with the next zone, composed of a few layers of chondroid and cartilage cells, which in turn was followed by a wide zone of relatively small hypertrophic cells forming about three-fifths of the whole cartilage. The matrix was scanty, particularly in the zone of hypertrophic cells, and it was also noted that the primary spongiosa, similar to that seen in the other specimens studied, was absent.

The staining patterns obtained with alcian blue, the PAS technique, and toluidine blue were respectively essentially similar in all the cartilages studied. One feature of interest was seen in the cranial synchondroses inasmuch as the cerebral surface displayed a preference for PAS staining and alcian blue when compared to the pharyngeal surface.

With exception of the degenerative zone the cells of the epiphyseal ends exhibited sudanophil granules (*Fig. 1*); the matrix showed a variable faint stain, except around the degenerative cells, where it was intensively stained. In the condyle

the matrix stained with sudan black around both hypertrophic and degenerative cells, which also was the case in the synchondroses (*Figs. 2, 3*). In a condyle from a 13-day-old rat the sudanophil area was clearly reduced together with the narrowing of the hypertrophic zone, which indicates an interrelation of these two features.



Fig. 3.—The basispheno-occipital synchondrosis from a 5-day-old rat. The zones of row cells and hypertrophic cells are narrower than correspondingly in the distal end at the tibia. The sudan black staining seems to reach into the matrix of the hypertrophic cell zone. ($\times 66$.)

DISCUSSION

The histological and histochemical characteristics of cartilages change with age. The transitional phase of development of the cartilages studied here has been the starting line in the transplantation studies referred to in the introduction, and is of interest from that point of view.

Histologically, at this stage of development, apparent differences between the condylar cartilage and that of the long bone ends are to be found in types of cells, proportions of cell zones, and the degree of structural organization.

The main histochemical difference between the condyle and the other cartilages, except perhaps the synchondroses, appears to be in the extent of the sudanophil area which in the long bones is confined to the degenerative cell zone, whereas in the condyle the whole hypertrophic zone stains with sudan black. This may be taken

to indicate that the condylar cartilage is largely in a state of mineralization, but, that, considering the fact that the primary spongiosa is virtually non-existent in the neck of the condyle (Irving and Durkin, 1965), it is not involved in an ordinary process of endochondral ossification. This concept is further supported by the findings that the condylar cartilage transplants in subcutaneous or brain tissue often undergo mineralization, but do not act as bone-promoting growth apparatuses in the sense of epiphyseal growth plates (Koski and Mäkinen, 1963; Koski and Rönning, 1965).

The cranial base synchondroses differ histologically from the long bones in the proportions of the zonal structures. Histochemically, two features are of interest here. The sudan black stain appears to reach into the hypertrophic cell zone matrix; this may, however, be an illusory phenomenon owing to the narrowness of this zone. The strong affinity for alcian blue of the cartilage cells at the cerebral surface probably indicates a local intensive appositional activity (Quintarelli and Dellovo, 1966). Transplantation experiments have shown that an independent growth potential appears to be slight in the

cranial synchondroses (Koski and Rönning, 1967); in their position they are likely to be subject to growth stimuli from the expanding brain and from the growing pharynx.

The findings of the present study support the conclusion that the condylar cartilage differs from other so-called growth cartilages; it is of some pertinence perhaps to recall that the origin of this cartilage is different from that of epiphyseal ones. It may further be postulated that the cranial synchondroses, resembling the condylar cartilages in many respects, are also responsive to functional stimuli in a manner bearing likeness to the condylar cartilage (Baume, 1961).

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OBSERVATIONS ON THE MISPLACED UPPER CANINE TOOTH

T. B. BASS, B.D.S., D.Orth., F.D.S. R.C.S.

Senior Lecturer in Orthodontics, London Hospital Medical College Dental School

APART from the third molar, the upper canine is more frequently misplaced from its rightful position in the dental arch than any other permanent tooth (Stones, 1962). It is suggested that the lengthy path the tooth has to follow from its developmental position under the floor of the orbit may account for its frequent deflection from the normal path of eruption (Hovell, 1966). Such misplaced teeth are usually discovered in the early teens on radiological examination undertaken to ascertain reasons for their non-eruption. The primary canine is frequently retained.

Several authorities have described the treatment of such unerupted teeth (Kettle, 1958; Hovell, 1958; Atherton, 1962; and Fordyce, 1964), but the aetiology of the condition is controversial.

Hitchin (1951) stated that the impaction of the canine was due to inadequate development in the size of the dental arch, but this opinion was countered by that of Dewel (1949) who considered that the impaction occurred most commonly in patients with normal arch form and occlusion. Dewel observed that as there is usually almost enough space available in the arch for the accommodation of the canine, dental crowding could not be of aetiological significance.

Lappin (1951) also noted the frequent impaction of the canine in cases with uncrowded arches in normal occlusion. He felt that the palatal deflection frequently seen may be initiated by a lack of resorption of the root of the primary canine, the eruption of the permanent tooth being delayed subsequently by the dense fibrous mucosa of the palate.

Kettle (1958) suggested that a narrow upper dental arch with retroclination of the labial segment was of significance. Local factors leading to misplacement of the canine were thought to be the presence of a dentigerous cyst in relation to the buried tooth and the congenital absence of the lateral incisor.

Miller (1963) reported on a number of cases where palatal displacement of the permanent canine was associated with the congenital absence of the lateral incisor.

The present investigation was undertaken in an attempt to reconcile some of these conflicting opinions.

The criteria of non-eruption are difficult to establish, as it appears that a number of canines, following palatal deflection, subsequently erupt palatal to the retained primary canine in the late teens or early twenties.

It was decided to examine the records of a number of patients whose buried canines had been surgically treated either by extraction or exposure, in an attempt to establish if any correlation existed between non-eruption of the canine and the type of occlusion. It could be argued, particularly in those cases where surgery was performed early, that the eruption of the canine would have occurred spontaneously if the patient had been left untreated. This criticism is valid, but surgery was not undertaken unless radiographs indicated a deflection of the tooth from its normal eruptive path.

THE SAMPLE

During the period 1950 to 1962, 9102 patients were either taken on for orthodontic treatment or seen for consultation at the orthodontic clinic at the Royal Victoria Hospital, Bournemouth. One hundred and fifty (1.65 per cent) of these patients had unerupted upper canine teeth which were surgically treated, either by extraction or exposure. The majority were subsequently treated by orthodontic means.

The 150 patients comprised 103 girls (68.7 per cent) and 47 boys (31.3 per cent). They all had been diagnosed and treated by, or under the supervision of, one operator. Twenty-five patients had bilateral buried canines. The remaining 125 patients had unilateral buried teeth of which 68 were on the left side and 57 on the right.

The following information was available from the patients' records:—

1. The anteroposterior relationship of the incisor apical bases (Skeletal classification). This had been assessed clinically by Ballard's (1948) method of incisor angle correction. No

cephalometric radiographs were available for any of the patients.

2. The type of malocclusion classified according to Angle by reference to molar relationship. Due allowance had been made for any forward drift of permanent teeth consequent upon premature loss of primary molars. An additional division had been added to Angle's Class II to describe those cases with a Class II molar

Table I.—SEX DISTRIBUTION

	Canine Group (per cent)	Random Group (per cent)
Male	31.3	46.2
Female	68.7	53.8

This greater frequency of buried canines found in the female is highly significant ($P < 0.01$)

Table II.—DENTAL BASE RELATIONSHIP

	Canine Group (per cent)	Random Group (per cent)
Skeletal Class I	67.3	55.1
Skeletal Class II	8.0	15.7
Skeletal Class III	24.7	29.2

These differences in skeletal pattern between the patients in the two groups are significant ($P < 0.05$)

relationship whose incisor relationship was not typically division 1 or division 2.

3. The position of the canine. This had been assessed by clinical and radiological examination and subsequently confirmed at operation.

4. A note of the congenital absence of any permanent teeth.

5. A record of the orthodontic treatment following the surgical treatment of the buried canine.

Reference models of a number of the patients were available, and these were examined in an attempt to assess the degree of crowding present in the upper dental arch. It was soon realized that with an incomplete series of models of patients at differing ages, the results of any such attempt would be unduly subjective, and hence the simple distinction was made between crowded and uncrowded arches.

To provide a standard with which these 150 patients might be compared, the notes of a random sample of 500 patients were examined. These were selected from the same group of 9102 patients seen between 1950 and 1962. These patients had all been examined clinically by the same operator, who had also examined the cases with buried canines. Eight of the 500 randomly selected cases had treated clefts of the palate,

and these were excluded for comparative purposes in view of the difficulty of classifying their malocclusions.

RESULTS

The findings are tabulated below in comparison with the details of the group with the buried canines. The result of statistical analysis by the

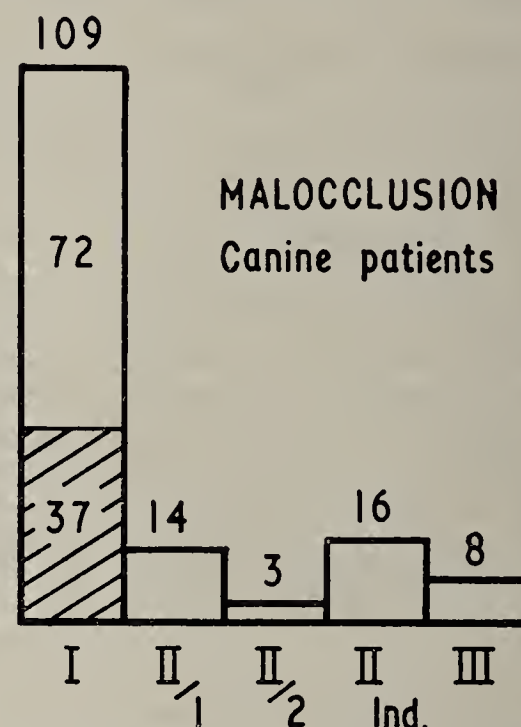


Fig. 1.—Distribution of canine cases within Angle's classification.

chi-squared test is given beneath each table (Tables I, II).

The distribution of the canine cases within Angle's classification is shown in Fig. 1.

Fifty of the 150 patients had uncrowded upper dental arches and of these 44 had Class I malocclusions and 6 had Class II, division 1 malocclusions.

Of the 44 Angle Class I cases without dental crowding, a further 7 had one or more permanent teeth congenitally absent, leaving 37 cases (24.7 per cent) with good occlusions apart from the presence of a buried upper canine either unilaterally or bilaterally.

To compare the malocclusions of the buried canine cases with the distribution of malocclusion in the randomly selected group, it was decided to exclude the 37 cases which had a buried canine as their sole malocclusion, as there was no comparable number of good occlusions in the random group (Table III).

In view of the small number of Class II, division 2 and Class III cases in the two groups, a further analysis was done to compare the distribution of Class II, division 1 cases only with the other malocclusions in both groups. This gave a highly significant difference ($P < 0.001$) (Fig. 2).

Third molars were excluded from the comparison of the frequencies of missing teeth in the canine and random groups as several of the

random group had been seen at too early an age for these teeth to have made themselves apparent radiologically (*Table IV*).

Exact details of the missing teeth in the canine group are given in the appendix.

Analysis showed these differences to be significant ($P < 0.01$) when the lateral incisors on the

and there was no residual spacing in the canine region.

The result was described as fair following exposure of the canine, when it had achieved a position where it could act as a functional tooth, but was not perfectly alined, i.e., a degree of lingual inclination or rotation present. A fair

Table III.—MALOCCLUSION

	<i>Canine Group</i> (per cent)	<i>Random Group</i> (per cent)
Class I	63.7	47.5
Class II, div. 1	12.4	30.5
Class II, div. 2	2.7	5.1
Class II indefinite	14.2	6.7
Class III	7.0	10.2

This difference in the distribution of malocclusion between the two groups is highly significant ($P < 0.01$)

same side as the buried canines were excluded from the comparison and highly significant ($P < 0.001$) when these lateral incisors were included (*Table V*).

TREATMENT

The records of the treatment of the unerupted canines of the 150 patients were analysed to ascertain whether the standard of the final result was influenced by the age at which the surgery was performed and the form of the subsequent treatment.

Final results were assessed as good, fair, and poor. A good result in the case of a surgically

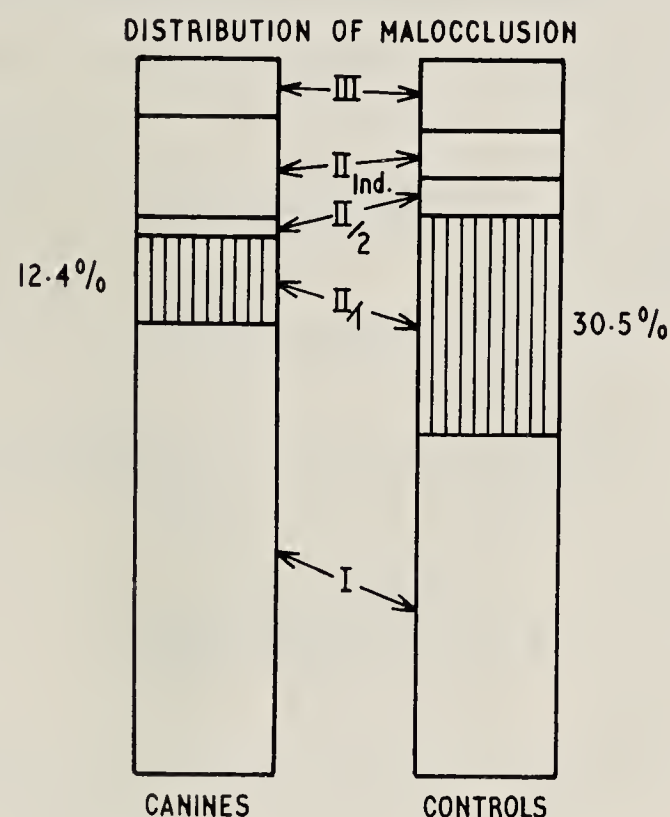


Fig. 2.—Histogram constructed from Table III.

result following extraction of the canine implied residual spacing in the canine region.

Poor results were few, as in the majority of cases where treatment did not proceed satisfactorily, the patient failed to return to allow a final assessment of the result to be made.

Table IV.—MISSING TEETH (EXCLUDING THIRD MOLARS)

Canine group	24.0 per cent of patients
Canine group (excluding lateral incisors on the same side as the buried canine)	17.3 per cent of patients
Random group	8.7 per cent of patients

Table V.—POSITION OF BURIED CANINE

Palatal	158 (90.3 per cent)
Buccal	15 (8.6 per cent)
Not assessed	1
Non-eruption caused by odontome	1

exposed canine was noted when the canine's final position was in good occlusion. In cases where the canine had been surgically removed, the result was assessed as good when the premolar offered a reasonably aesthetic substitute for the canine

Table VI.—OPERATIVE DETAILS

POSITION OF TOOTH	TYPE OF OPERATION	
	<i>Extraction</i>	<i>Exposure</i>
Buccal	11	4
Palatal	58	100

The operative details of all the 150 patients are shown in *Table VI*.

The discrepancy in numbers is accounted for by the two teeth whose position had not been assessed.

The treatment of 110 of the 150 patients was completed. These patients had between them 128 teeth, 42 of which were extracted and 86 of which were exposed.

Buccally Placed Canines

Of 13 patients with 15 buccally placed canines, 10 completed treatment having been operated

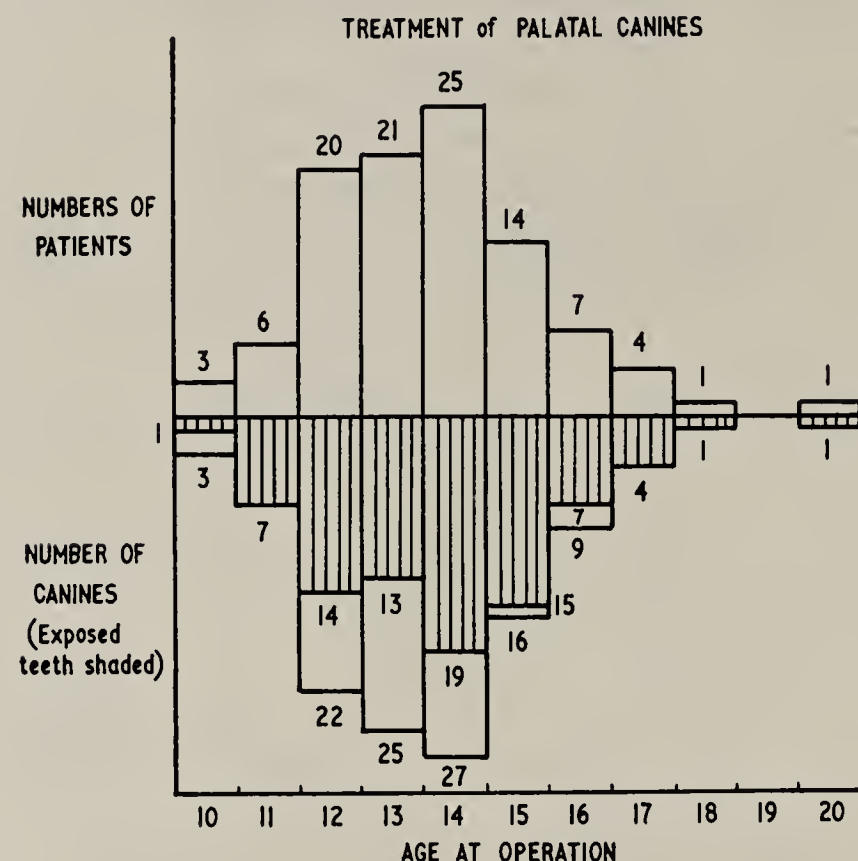


Fig. 3.—Operative details for patients with palatally placed canines.

on at an average age of $13\frac{1}{2}$ years. These patients all showed a degree of upper arch crowding which was relieved by the extraction of the canines in 8 of the 10 cases. Of the 2 canines which were exposed, 1 was subsequently extracted when the

No active orthodontic treatment was required in 6 of the cases, 2 were treated with removable appliances and 2 with fixed appliances, none for more than a few months.

A good result was achieved in 6 cases and a fair one in 3, where there was some residual spacing in the canine region.

No further analysis of these cases was attempted in view of the small numbers involved.

Palatally Placed Canines

The treatment of 102 patients with 115 palatal canines was completed. Fifteen of these patients had bilateral buried canines and a further 3 also had the other canine buried but buccally placed. The details of these 3 patients appear in this section and is the section on buccally placed teeth.

The age at which the operation was performed on these 102 patients is shown in Fig. 3. Also shown is the number of canines extracted and exposed in each age-group.

It has been suggested that the ease with which misplaced upper canine teeth can be brought down into the dental arch is dependent on the age of the patient, the prognosis deteriorating as age advances (Hovell, 1966).

To examine this, the details of the treatment of the 82 palatally placed canines which had been exposed were examined. In view of the small number in each age-group, the cases were divided into three subdivisions depending on the age at which the surgery had been performed.

The first subdivision comprised patients operated on at ages 10, 11, and 12 years. These children possessed 22 buried canines. In 2 cases poor co-operation led to a cessation of orthodontic treatment, leaving 20 cases for comparative purposes.

Table VII.—TREATMENT OF EXPOSED PALATAL CANINES

AGE AT OPERATION	'DELAY' TIME (months)	APPLIANCE TIME (months)	TOTAL TIME (months)	RETENTION TIME (months)	RESULT	
					Good	Fair
10, 11, and 12 (20 teeth)	9	12	21 (range 14-37)	8	13	7
13 and 14 (31 teeth)	7	9	16 (range 7-35)	7	21	10
15 and over (27 teeth)	6	10	16 (range 9-28)	5	22	5

patient's co-operation failed, and was thus assessed as a poor result. In the other case in which a buccal canine was exposed, the crowding had already been relieved by the loss of first permanent molars.

The second subdivision comprised patients operated on at 13 and 14 who possessed 32 canines. In this group one patient's co-operation failed and the tooth was extracted, leaving 31 for comparative study.

The third division comprised patients operated on at the age of 15 years and over. These patients had 28 buried canines between them. Again co-operation failed in one case, which was excluded for comparative purposes.

All but 7 of the 78 teeth were treated with fixed orthodontic appliances. In several cases treatment was initiated with a removable appliance to maintain space while the canine erupted to a position where it could be banded.

Fixed appliances with palatal arches and auxiliary springs were used initially, but most cases were completed with multibanded appliances with buccal archwires. Frequently, a lower bite plane appliance was employed to facilitate the movement of the canine from lingual to buccal occlusion.

The following periods of time were compared for the three divisions:—

1. 'Delay' time. This was the average time in months which elapsed between the date of operation and the fitting of the first appliance, either removable or fixed. It represents, in most cases, the time taken for the canine to erupt to a position where it was accessible to movement by orthodontic springs.

2. Appliance time. This was the average time of active appliance therapy in months, either with fixed or removable appliances, or both.

3. Total time—the above figures added.

4. Retention time. This was the length of the average retention period subsequent to active orthodontic therapy.

These details for the three groups are shown in *Table VII*. The standard of result achieved in each group is also shown.

The average period of time from operation to completion of active orthodontic treatment is slightly reduced in the two older subdivisions by 3 patients (2 in the age 13–14 division and

To compare the results of differing forms of treatment, three groups of patients were examined.

Thirty patients had had 37 canines exposed; 30 patients had had 33 canines surgically removed; and 34 patients had had 38 canines exposed and another tooth removed to make space for the accommodation of the canine in

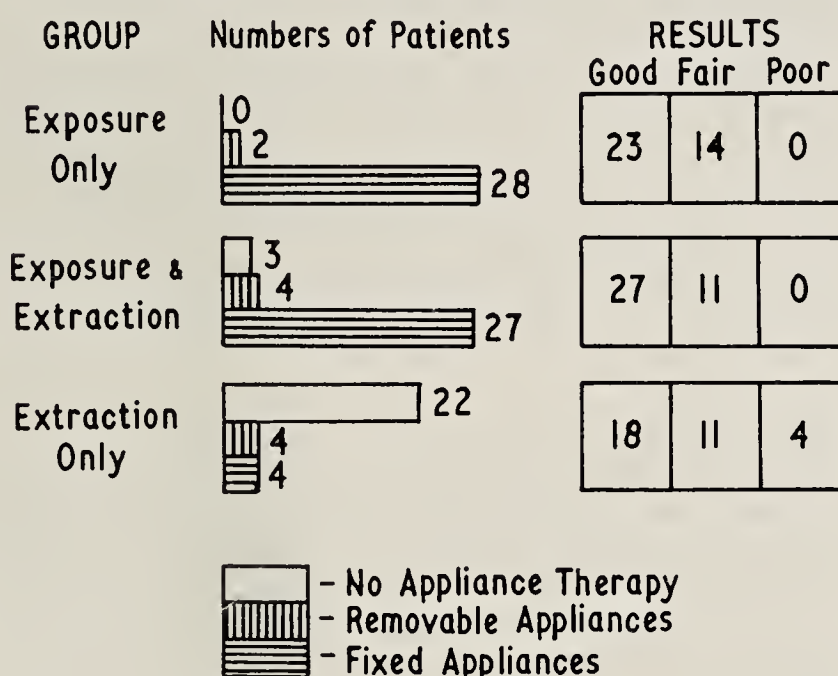


Fig. 4.—Postoperative treatment of the groups of patients whose details are shown in *Table VIII*.

the dental arch. For this last group space was created by the extraction of the first premolar in 23 cases, the lateral incisor in 4 cases, and the first molar in 7 cases.

Table VIII and *Fig. 4* give the salient details for the three groups.

Uncompleted Cases

An examination of the notes of the 40 uncompleted cases was made to discover at what stage

Table VIII.—DIFFERING FORMS OF TREATMENT OF PATIENTS WITH PALATALLY PLACED CANINES

GROUP	NUMBER OF PATIENTS	NUMBER OF TEETH	AVERAGE AGE AT OPERATION
Exposure only	30	37	14 yr. 8 m. (range 11·8–20)
Exposure and extraction	34	38	15 yr. 4 m. (range 10·2–17·7)
Extraction only	30	33	13 yr. 7 m. (range 10·5–15·3)

1 in the 15 and over division) for whom no active postoperative orthodontic therapy was necessary. These 3 patients all had preoperative orthodontic treatment to create space for the canine.

the treatment was interrupted. Findings are given in *Table IX*.

Nine of the patients who discharged themselves had had canines exposed at an average age of 14 years 8 months—the same as the group which

completed treatment (*see Table VIII*). Five of these were undergoing active appliance therapy, 4 with fixed appliances. It is presumed that these fixed appliances were removed by the patients'

Table IX.—UNCOMPLETED CASES

Patients still under observation or treatment	5
Patients removed and referred to other orthodontists	4
No follow-up attempted after extraction of canine	21
Patients discharging themselves	10

own dental surgeons or by the patients themselves.

DISCUSSION

The incidence of 1.65 per cent for buried canines requiring surgical treatment found in this survey is almost certainly higher than would be found in most orthodontic practices. This may be accounted for by the fact that the orthodontic clinic at the Royal Victoria Hospital, Bournemouth, provides a specialist orthodontic service for patients from a wide area, including the large towns of Bournemouth and Poole, most of the county of Dorset and the western part of Hampshire. Many practitioners in this area who undertake simple orthodontic treatment refer their more complex cases to the clinic.

The finding of a significantly higher frequency of buried canines in females is in agreement with that of Dewel (1949). No explanation can be suggested to account for this, and further examination of the records in an attempt to relate this difference to differences in degree of crowding and type of malocclusion in the two sexes gave no positive result.

All observers agree that the unerupted upper canine is deflected palatally more frequently than buccally, and the present survey confirms this.

The finding of the buried canine or canines as a sole malocclusion in nearly one-quarter of the cases studies is at variance with the opinions of Dewel, who states that normal occlusion is seen in a majority of buried canine cases, and of Hitchin who considers dental crowding to be an important aetiological factor.

The significantly low frequency of buried canines in association with Angle Class II, division 1, malocclusions can be explained by the greater amount of space available for the eruption of the canine in such cases. Hovell (1966) considers that the misplacement of the canine occurs as a result of an abnormal mesial inclination of its path of eruption. The subsequent deflection towards the palatal or buccal aspect of the dental arch takes place as the erupting canine approaches the root of the lateral incisor.

The typical proclination of the incisor seen in the Class II, division 1 case will reduce the likelihood of an early palatal or buccal deflection of the canine, and give the tooth a greater opportunity to resume its correct eruptive path.

The number of buried canines occurring in cases of Angle Class II, division 2, Class II indefinite, and Class III malocclusion are too small for any definite conclusions to be drawn. It is, however, interesting to note that of 4 instances of canines causing resorption of the roots of central or lateral incisors, 3 occurred in Class II, division 2 cases. An explanation of this may be that the typical lip morphology of the Class II, division 2 case does not allow the erupted incisor to move away as the erupting canine approaches its root.

The relatively high frequency of buried canines in the Class II indefinite cases may be associated with the crowding invariably seen in the upper dental arch. As this malocclusion is caused by what may be described as 'forward shift of the upper buccal segments' (Hooper, 1963), it is not unreasonable to suggest that one result will be lack of space for the canine. In all but one of these cases the canine was deflected into the palate.

The significantly high level of congenitally missing teeth in the buried canine group compared with the random group is the most interesting finding of this investigation. As far as can be ascertained it has not been reported previously, although the effect of the missing lateral incisor on the path of eruption and subsequent position of the canine is well known. A few of the cases of partial anodontia in the canine group suffered from multiple missing teeth (*see Appendix*). In these it could be suggested that the malposition of the canine resulted from the same disturbance of the dental lamina that led to the agenesis of the permanent teeth.

A further examination of the records of the patients with missing teeth was made to compare the numbers of the most commonly missing teeth (upper lateral and lower second premolars) in the canine and random groups. When missing upper lateral incisors on the same side as buried canines had been excluded, the percentages of lower second premolars and upper lateral incisors missing in the two groups were almost identical. This suggests that the general level of missing teeth in the buried canine group was raised, rather than any particular individual tooth being affected.

It is difficult to account for this differing frequency of missing teeth in the buried canine and random groups apart from the suggestion previously made that both missing teeth and ectopic canines are caused by the same minor disturbance of the dental lamina.

Passing to the treatment of the 150 cases, it appears at first sight that the completion rate at

73.3 per cent is fair only, but when the details given in *Table IX* are taken into account it is apparent that 10 patients only remain unaccounted for.

The comparisons made between results achieved in cases where the canine was exposed and cases where the canine was extracted are not truly valid, as a much higher proportion of cases with extracted canines were not seen for final assessment (*Table IX*). In several instances this was because the decision to extract was made at the request of the patient, expressly to avoid the subsequent orthodontic treatment. It was realized that there was little likelihood of follow-up appointments being kept.

No useful comments can be made on the treatment of the buccally placed canines in view of the very small number of teeth involved. However, it is interesting to note that all the cases with buccally placed canines also had dental crowding in the upper arch. It may be that this form of displacement of the canine results from extreme expression of the typical form of upper arch crowding which usually leads to buccal exclusion and tardy eruption of the canine.

As would be expected, more than half the patients with palatal canines were operated on at 12, 13, and 14 years of age. The few patients whose treatment commenced earlier than this all had some other malocclusion present in addition to the misplaced canine, which was presumably an incidental finding at routine radiological examination.

Table VII, however, provides the interesting information that there were negligible differences in the treatment times of the different age-groups. The 'delay' time for the youngest age-group was actually longer than that for the oldest age-group, although this can be accounted for by the desire of the operator to push forward as rapidly as possible with the treatment of the older patients. No real conclusions can be drawn from the differing standards of the results in these age-groups as the numbers involved are too small.

It does appear that the age at which treatment was commenced had little bearing on the time taken over treatment and the standard of the result achieved in the patients in this survey.

Examination of *Fig. 4* shows that the proportion of good results is highest in the group in which the canine was exposed, and lowest in the group in which the canine was extracted, but that the differences are relatively insignificant. As expected, a minimum of postoperative orthodontic treatment was required for the extraction group, while only 3 of the patients in the other two groups escaped postoperative appliance therapy and 2 of these had been treated preoperatively.

The average age at which the operation was performed is also markedly different for the groups, canines being extracted on average more

than seventeen months before they were exposed.

In the exposure groups active treatment continued well into the sixteenth year, and fixed appliances were required in a large majority of cases.

SUMMARY AND CONCLUSIONS

The notes of 150 patients whose misplaced upper canines had been surgically treated were examined. Comparisons were made between these patients and a random sample of 492 attending the same clinic.

In almost one quarter of the cases the buried canine was the sole malocclusion present. The frequency of misplaced canines was significantly low in association with Angle Class II, division 1 malocclusion. An explanation is advanced to account for this.

The frequency of the congenital absence of permanent teeth was significantly higher in the patients with misplaced canines compared with the patients selected at random. This finding cannot be explained.

The time taken to aline the exposed canines did not increase with age, as is suggested by some authorities. Slightly better results were obtained following exposure and alinement of the canines than were achieved when the canines were extracted. These were achieved, however, at the expense of a lengthy course of orthodontic treatment with fixed appliances, extending on average into the sixteenth year. Patients whose canines were removed required much less treatment, and this was performed at an earlier age.

It may be concluded that when definite indications exist, canines can be exposed and alined as rapidly in the late teens as in the early teens; however, lengthy courses of orthodontic treatment can be avoided by extraction of the canine, and the survey shows little difference in the results achieved in suitable cases.

Acknowledgements

I am greatly indebted to Mr. J. D. Hooper for permission to examine the records of his patients and for the help he and his staff gave me and the interest he took in the work. Mr. R. G. Torrens, Consultant Dental Surgeon at the Royal Victoria Hospital was responsible for all surgical treatment; I am grateful for his help and interest.

Dr. Michael Alderson of the Medical Research Council Social Medicine Unit at the London Hospital gave invaluable advice on statistical matters.

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APPENDIX

DETAILS OF MISSING TEETH AND RELATED MISPLACED CANINE OR CANINES.

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$\frac{ 8}{85 58}$	$\frac{3 }{}$	$\frac{2 }{}$	$\frac{ 3}{}$	$\frac{5 5}{}$	$\frac{3 3}{}$	$\frac{8 8}{}$	$\frac{ 3}{}$
$\frac{8 8}{8 58}$	$\frac{ 3}{}$	$\frac{ 2}{}$	$\frac{3 }{}$	$\frac{5 5}{}$	$\frac{ 3}{}$	$\frac{ 8}{}$	$\frac{3 }{}$
		$\frac{ 4}{}$	$\frac{3 3}{}$	$\frac{85 }{}$	$\frac{ 3}{}$	$\frac{8 }{}$	$\frac{3 }{}$

In addition to the above, there were 10 patients with 1 missing lateral incisor only on the same side as the misplaced canine.

DISCUSSION

Mr. A. M. Cookson, opening the discussion, said that, in recent years, there had been several papers delivered to the Society on the subject of unerupted maxillary canines, but, as far as he was aware, this was the first time that there had been any attempt to introduce a detailed analysis of such cases and in anything like such large numbers.

Surely, as regards aetiology, by far the most likely state of affairs was that the tooth was malplaced at the time of formation; that it formed in the wrong position. This doubtless resulted from some disturbance of the dental lamina, and it was doomed to malposition from the start. Other facts such as crowding might make matters worse, but Mr. Bass showed that there was a highly significant correlation between the incidence of missing teeth and misplaced canines.

His second query concerned crowding. Mr. Bass found that two-thirds of the patients he investigated with misplaced canines had crowded upper arches. However, he did not say what percentage of his randomly chosen control group were crowded. Did Mr. Bass in fact feel that crowding was an important aetiological factor, or merely a secondary complication? In other words, had a misplaced canine allowed, for example, a forward shift of buccal segments, or vice versa—had forward shift of the buccal segments caused the misplacement?

There was a comparable query concerning his finding that these cases showed a significantly higher frequency of occurrence in females. His tables

showed that the great majority of the cases were between 12 and 14 years of age when girls were, generally speaking, physically and dentally more developed than boys anyway. The absence of canines was therefore more likely surely to have been detected by this age in girls, for this very reason.

The third point was that he noticed that no mention was made of any correlation with the presence or absence of the deciduous canines in these cases. He wondered if Mr. Bass had any observations to make on the importance of those teeth in establishing an eruptive path for the canines.

Lastly, he had two small queries concerning treatment. Mr. Bass did not mention any cases where the canines were left in place; he believed that there were some authorities who were in favour of doing this if they were very high up and causing no signs or symptoms.

Also, in the description of appliances used, Mr. Bass made no mention of the use of pins. Was this purely because none of the cases warranted their use, or did he feel in the light of subsequent experience that some of the treatment times might have been shortened by their use?

Mr. C. D. Parker said that he noticed Mr. Bass had shown in most of these cases that there was a delay in starting treatment following exposure of the crowns of the canine. Recently, he had been placing a silver cap on to the exposed tooth at the time when the pack was removed. The silver cap had a loop on the palatal aspect so that force could be applied in an

occlusal direction and thus counter the tendency for the tooth to submerge as it moves buccally.

On occasions, having moved the canine into the arch, one found the apex of the canine was palatally placed. Correction of this by moving the canine apex buccally was difficult because the tooth appeared to depress.

He wondered whether, in Mr. Bass's assessment of cases, he found at the end of treatment any canine with mobility. Certainly, in his experience this occurred along with a tendency, once appliances were discarded, for the incisal tip of the canine to be at a higher level than the other teeth in the arch.

Mr. Bass, replying to *Mr. Cookson*, said he thought it could be assumed that any patients referred for orthodontic treatment or opinion must have some form of malocclusion and the point he was trying to make was that 37 of the canine cases had no malocclusion at all, apart from the buried canine.

Mr. Cookson mentioned the question of primary canines; the records showed that retained primary canines were present in association with 93 of the buried permanent canines—in other words with rather more than half of the total of 175. Whether this was of significance or not, he was not qualified to judge.

Another interesting point was that in the 37 cases of good occlusions, apart from the buried canines, 29 had retained the primary canines and only 8 had lost these teeth.

Mr. Cookson also asked whether any patients had had their buried canines left in position and had not been surgically treated. Unfortunately, he was unable to find out because this survey related to patients who had had surgical treatment for the buried canines, and to find out if any patients had had buried canines left in position would require the examination of 9000 series of notes.

Mr. Cookson asked whether any pins were inserted in the buried canines. He had not intended to deal with treatment as the survey was done on cases treated in the President's clinic and under his supervision, but it was not the President's practice to use pins as far as he knew in any case, and none of the records showed the use of pins.

In reply to *Mr. Parker*, whose question largely referred to the treatment of the buried canine, he could only tell him what the President's invariable practice was in these cases. He insisted on a substantial exposure of the buried tooth and did not have a previously prepared plate as some operators did. He insisted on a band being made for the buried canine at the first opportunity and a spring engaged beneath a hook on this band.

Professor C. F. Ballard said that it was nice to have some of one's subjective views confirmed statistically.

He always had thought that buried canines were at least partly not the result of crowding because he had seen it so very often in mouths in which there was spacing.

One of the things that had been brought out was the relationship between buried canines and absence of teeth. He wondered whether there might be a high correlation here, because in females a practitioner would notice the absence of a lateral or the presence of a retained deciduous lateral, and therefore there was a higher percentage of cases referred with that condition.

Mr. P. Vig said that if there was an aetiological relationship between misplaced canines and genetically missing teeth, one would expect to find a number of malformed canines as well somewhere in the intermediate series. He asked if this was found in any of the samples.

Mr. Bass replied that he was afraid it was not.

Mr. F. Allan said that he was astonished at the number of extracted canines and wondered whether this was due to the fact that the complexity of getting them into place in relation to the number of patients to be treated at the clinic was too great to bother about them, or whether the final result with the canine extracted was better than if the canine had been actually put into place.

Mr. Bass said that he was not going to make any comment at all about the treatment of the cases.

Mr. J. D. McEwen said it had been suggested that the presence of an open apex indicated a better prognosis for the eruption of a malpositioned canine tooth. He asked *Mr. Bass* if he thought his figures cast some doubt on this.

Mr. Bass said he thought that they must, in view of the fact that it was apparently as easy to bring the canine down into the arch in the older patients as it was in the younger ones.

The President said he would try and help *Mr. Bass* in his difficulty of not wanting to comment on treatment he had not carried out himself or over which he had not complete control. The reason for advising this treatment, that is, exposing the tooth—he himself was astonished at the number of cases *Mr. Bass* had found—was to avoid a denture in a young person. It is very worth while treatment in a young person with a fine arch in which the alternative to alining the misplaced canine is to fit a denture. The canine would be removed in those cases where a reasonable appearance was possible without a denture and where an enormous amount of orthodontic treatment would thereby be avoided. It was a burden on the average family, and one was very glad to be able to spare them this burden if one could get a result which, on one's own judgement, was satisfactory for the particular patient.

A CASE OF PARTIAL ANODONTIA AND SUPERNUMERARY TOOTH PRESENT IN THE SAME JAW

DOUGLAS MUNNS, V.R.D., L.D.S. R.C.S. (Eng.)

Birmingham Regional Hospital Board

FROM time to time we see patients who, although they are not an immediate orthodontic problem, do present developmental features which, when analysed, help us with diagnoses of other cases. The details of such a patient are recorded here—a patient who presented with congenitally missing

lateral incisors and a supernumerary premolar tooth in the maxilla.

PREVIOUS INVESTIGATIONS

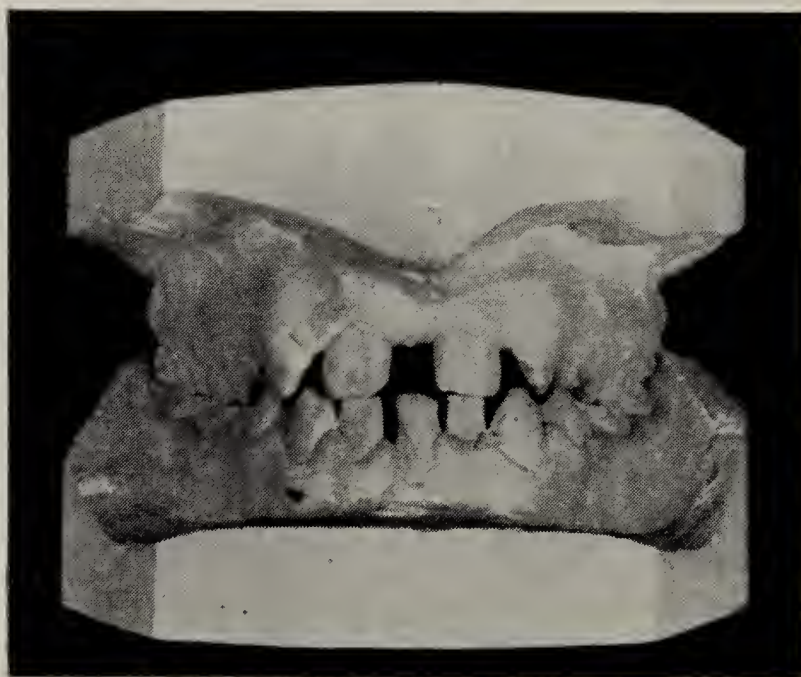
Many surveys have been undertaken on the incidence of congenitally absent teeth in the



A



B



C



D

Fig. 1.—Models of the condition described. A, Left lateral; B, Right lateral; C, Anterior, and D, Occlusal view of upper model only.

Presented at the Country Meeting held in Bristol on 14 April, 1967.

permanent dentition and, third molars excepted, the mandibular second premolars are the most common teeth to be missing and the maxillary lateral incisors come second on the list. Owing to the later development of third molars, none of the investigations has recorded details of these teeth. *Table I* gives a summary of a few of these reports based on clinical and radiographic

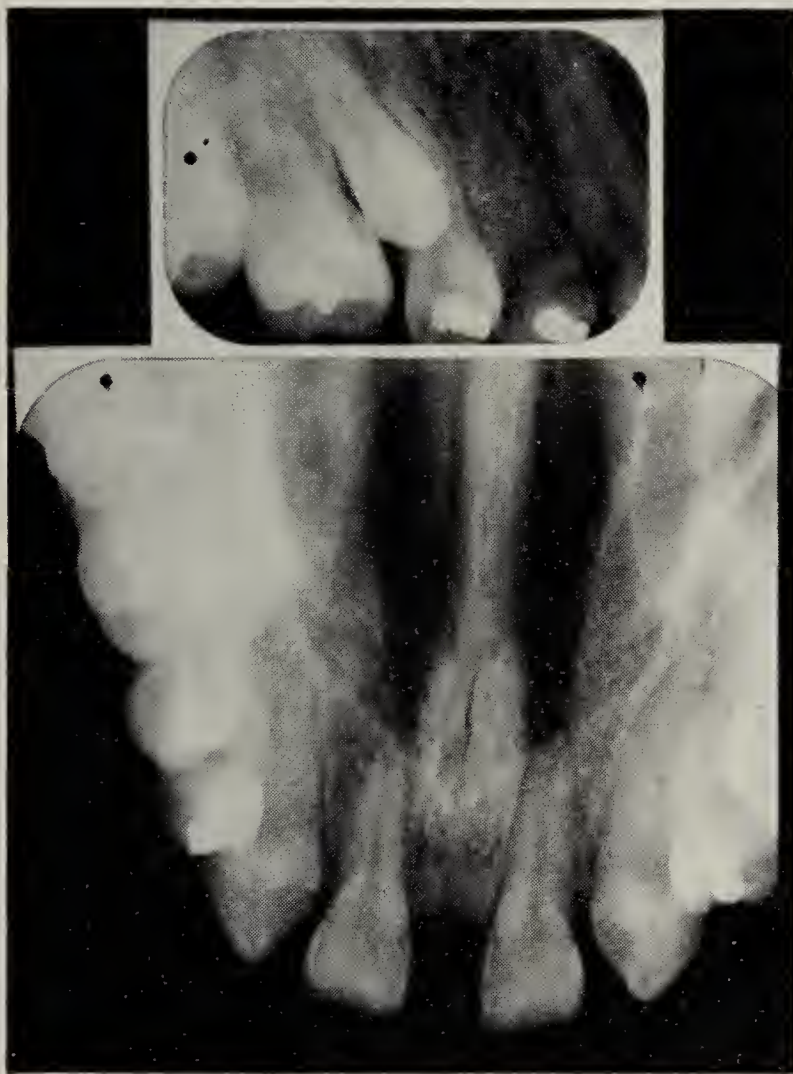


Fig. 2.—Intra-oral and occlusal radiograph.

examinations; the cases of Glenn (1964) and Rose (1966) were of those seen in orthodontic practice whereas the remaining investigators were examining general groups of schoolchildren, and so one would expect variations between the two groups. From the variation in the percentages of teeth absent as quoted by the various workers, it would obviously be very dangerous to be dogmatic about the most commonly absent teeth, but clinical experience does follow the general pattern; one wonders to what extent the geographical location of the survey has affected the result.

From reported cases of supernumerary premolar teeth in the maxilla it would appear that this condition is apparently quite rare. Stafne (1932) found the incidence to be 1·8 per cent (compared with 45·4 per cent for central incisors) in 500 cases with supernumerary teeth present that he investigated. Most reports of supernumerary premolar teeth seem to be of patients from the East or Africa, and Still (1945) suggested that

one patient in every one hundred in Southern Rhodesia had an extra premolar tooth.

Only a few workers have conducted surveys in which both the incidence of congenitally absent teeth and the presence of supernumerary teeth has been recorded. *Table II* gives a summary of their findings. In only one survey, Werther and Rothenberg (1939), is it recorded that 0·7 per cent of affected cases had both supernumerary and congenitally missing teeth. This figure perhaps



Fig. 3.—Radiograph of extracted tooth (crown fractured during removal).

has more significance to us if we appreciate that 1·5 per cent of their cases had missing mandibular or maxillary first molars, a condition which we rarely find. Dockrell (1967) reports that in the Aran survey he found a girl who had an upper right permanent lateral incisor missing and two additional mesiodens.

CASE REPORT

Our patient, a girl of 17 years, was well developed for her age and the dentition was well advanced (*Fig. 1*). Three third molar teeth had already erupted and the fourth one was found to be present on X-ray. She had missing maxillary lateral incisors and there was no evidence of any unerupted teeth in this area on X-ray (*Fig. 2*) nor was there a history of them having been extracted. There were only three mandibular incisors present, but we were informed by the patient that one of these had been extracted because of gross irregularity of the front teeth. In the right maxilla, there was an additional premolar tooth lying on the palatal aspect between the second premolar and first molar teeth (*Fig. 1D*). This tooth was well formed,

Table I.—SUMMARY OF RESULTS OF PREVIOUS INVESTIGATIONS OF MISSING TEETH

AUTHORS		Byrd	Dolder	Glenn	Rose	Werther and Rothenberg	Averages
PLACE AND YEAR OF SURVEY		U.S.A. (1943)	Switzerland (1937)	U.S.A. (1964)	U.K. (1966)	U.S.A. (1939)	
TOTAL CHILDREN EXAMINED		2835	10,000	777	6000	1000	
AGE-RANGE OF CHILDREN EXAMINED		4-15 yr.	3-15 yr.	3-16 yr.	7-14 yr.	3-15 yr.	
NUMBER OF CHILDREN WITH MISSING TEETH		79	340	40	258	23	
PERCENTAGE OF CHILDREN WITH MISSING TEETH		2.78	3.4	5.15	4.3	2.3	
Percentage of individual types of teeth missing related to the total number of missing teeth in each sample	$\frac{7}{17}$	Nil	0.8	1.55	Nil	3.0	0.93
	$\frac{6}{16}$	Nil	Nil	1.55	0.42	1.5	0.69
	$\frac{5}{15}$	16.54	25.3	12.3	19.83	14.5	17.69
	$\frac{4}{14}$	2.75	5.5	Nil	2.5	3.0	2.75
	$\frac{3}{13}$	Nil	1.8	Nil	1.88	6.5	2.04
	$\frac{2}{12}$	16.54	12.3	32.3	24.43	38.5	24.81
	$\frac{1}{11}$	2.06	Nil	Nil	Nil	Nil	0.51
	$\frac{1}{11}$	0.69	2.2	1.55	6.47	3.0	2.78
	$\frac{2}{12}$	1.27	1.1	Nil	1.89	6.5	2.13
	$\frac{3}{13}$	0.69	Nil	1.55	0.21	3.0	1.09
	$\frac{4}{14}$	2.75	3.0	Nil	0.85	1.5	1.6
	$\frac{5}{15}$	56.55	47.3	49.2	40.71	14.5	41.65
	$\frac{6}{16}$	Nil	Nil	Nil	0.42	1.5	0.38
	$\frac{7}{17}$	Nil	0.7	Nil	0.42	3.0	0.82

Table II.—SUMMARY OF INVESTIGATIONS WHERE MISSING AND ADDITIONAL TEETH WERE RECORDED

AUTHORS	Byrd	Dolder	Gardiner	Werther and Rothenberg
YEAR	1943	1937	1955	1939
SAMPLE	2835	10,000	1000	1000
PERCENTAGE OF CHILDREN WITH MISSING TEETH	2.78	3.4	1.6	2.3
PERCENTAGE OF CHILDREN WITH ADDITIONAL TEETH	0.56	0.3	0.5	1.6

had the anatomical form of a normal upper premolar, and as an extracted tooth would have been very difficult to distinguish from a normal upper premolar. Unfortunately, the crown was fractured during extraction, but as will be seen from X-ray of the extracted tooth it appears quite normal in every respect (Fig. 3).

The skeletal form was Class III, with mandibular first molars one unit prenormal (Fig. 1B). There was a decreased overbite and overjet with an almost edge-to-edge occlusion (Fig. 1C). There was a large midline diastema and the right mandibular canine was slightly labially placed. The general condition of the mouth was poor with very heavily filled first molars; there was a marked marginal gingivitis with considerable subgingival tartar and oral hygiene was sadly lacking.

Unfortunately her general dental practitioner had just emigrated to Canada and so could not give us any first-hand information of the patient's past dental history. He had, however, kept very careful records which showed that the deciduous lateral incisors were present and the right mandibular central incisor was extracted three years before we saw the patient. There did not appear to be a family history of missing anterior teeth, but it is of interest to note that both the patient's father and younger brother do have a very similar basal form with a midline diastema and spacing of anterior teeth.

DISCUSSION

True partial anodontia, of which this case is a typical example, is due to suppression of the odontogenic epithelium resulting in aplasia of the enamel organ. As the deciduous lateral incisors were present in this case, development must have been affected after the tooth germ for the deciduous tooth had been formed (i.e., after the 10th–12th week of intra-uterine life). It is not possible to say whether this is hereditary in this case, as it has only been possible to trace back through one generation. On the other hand, the presence of supernumerary teeth is due to hyperactivity of the dental lamina, on which subject the following observations have been made by Stones (1961):—

1. It is sometimes regarded as an atavistic tendency to the typical mammalian dentition, which has four premolars in each segment.

2. Another theory is that the tooth germ of the normal series has undergone dichotomy: if the division is equal then the supernumerary resembles its neighbour (as in this case), but if the division is unequal then the additional tooth is malformed and quite often conical in shape.

3. A further possibility is that the supernumerary tooth is derived from clumps of epithelium that become activated to tooth formation after the breaking up of the tooth band.

Whether or not there is any common factor causing suppression of the odontogenic epithelium resulting in the absence of lateral incisors and hyperactivity of the dental lamina resulting in the additional premolar, it is not possible to postulate.

SUMMARY

Findings of previous investigations have been reviewed and tabulated. A case demonstrating missing teeth and additional teeth in the same jaw has been described, and the developmental features discussed.

Acknowledgements

I should like to thank my colleagues working with the Birmingham Regional Hospital Board for their suggestions and help with the preparation of this paper, and also the Photographic Department of the University of Birmingham for their help with the preparation of some of the photographs.

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RESEARCH REPORTS

THE CRANIAL BASE OF THE DEVELOPING HUMAN FOETUS. By T. H. M. WYNNE, PH.D., B.D.S., F.D.S., D.ORTH. R.C.S.

THE cranial bases were measured in 341 foetuses between the ages of 10 and 40 weeks. The three points chosen to represent the base were nasion, pituitary point (Ford, 1955), and basion.

The average reading for the angle of the cranial base, as determined by the upper and lower 95 per cent confidence limits on the mean, was shown to be constant, or very nearly constant, at 138° . There was thus no evidence of alteration with age as expressed by many authors.

The growth-rate of both the anterior and posterior cranial bases from 10 to 16 weeks was found to be quite uniform, but this was followed by a gradual slowing of the rate up to full term. The anterior cranial base doubles in size from 10 to 15 weeks, but by full term it is only $4\frac{1}{2}$ times larger than the 10-week size. The length of the posterior cranial base doubles from 10 to 19 weeks, but is only just over three times larger than the 10 week size by full term.

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OBSERVATIONS ON TOOTH ERUPTION. By N. R. THOMAS, Department of Anatomy (Oral Biology), University of Bristol

SEVERAL theories exist concerning the forces involved in tooth eruption. Most of them rely upon a pressure force developing beneath or around the root which must ultimately depend upon and react against the pressure of blood in the capillaries supplying the area. It has been shown, however, that a 20-per-cent reduction in arteriolar pressure produced by hypotensive drugs makes no alteration to the eruption rate of the

rat incisor. Furthermore, the eruptive force in these teeth has been shown to be in excess of that generated by blood- or tissue-pressure. Since this work has been entirely undertaken on the continuously growing incisor it raises doubt about the permissibility of extrapolation of these results to non-continuously growing teeth, such as those of man. It was therefore proposed to ascertain the effect of long-standing raised blood-pressure on the eruption of the third mandibular premolar in Beagle dogs. Superimposition of tracings from lateral radiographs of the bisected jaws of control animals showed that the middle part of the lower border of the mandible and the inferior dental canal are reliable reference points. Measurements taken between these points and the tip of the cusp or amelodentinal junction shows that the eruption in the experimental animals ($750 \mu \pm 50 \mu$ per year) does not significantly differ from the control rate. It is therefore inconceivable that the tooth is pushed out of its socket by the development of tissue or blood pressure. It is further demonstrated that the eruption of the non-continuously growing molar as well as the continuously growing incisor of rat is retarded during the administration of a lathyrogen (0.1 per cent B amino aceto-nitrile bisulphate) in the drinking water, a known inhibitor of collagen maturation. This suggests that eruption is produced by a pulling force engendered by the maturation of collagen in the periodontium and implies that its 'turnover' must be considerably higher than that normally ascribed to it in order to maintain the process of eruption over extended periods. Autoradiographic studies on the periodontia of rats and rabbits given intraperitoneal tritiated glycine, proline, and methionine confirm the high 'turnover' of collagen consistent with the tractional theory of eruption.

Presented at the Research Meeting held in Bristol on 13 April, 1967.

THE MORPHOLOGICAL BASES OF PROGNOSIS DETERMINATION AND TREATMENT PLANNING

C. F. BALLARD, F.D.S., D Orth. R.C.S., F.F.D. R.C.S. (Irel.), M.R.C.S., L.R.C.P.

Professor of Orthodontics, Institute of Dental Surgery

GEORGE NORTHCROFT, in his first Presidential address to the Society (1909) appealed to members to cultivate wide views on a 'knowledge of all methods and an understanding of how to apply that knowledge to individual cases.' He issued a warning not to overdo the correction of malocclusions. This to me is recognition of the fact that orthodontists should accept the limitations imposed by inherited characteristics. Darlington (1964) recently said, 'attributing differences to the environment which primarily spring from heredity is most widespread as a social fallacy.' In spite of the fact that lip service is paid to heredity as an aetiological factor many present-day orthodontic philosophies appear to be based on the assumption that malocclusions are environmentally produced. One gets the impression that they, the orthodontists, feel morally bound to produce an ideal occlusion ignoring individuality. Again, to quote Darlington, 'the terrible problem of individual diversity which confronts the medical profession has been submerged under an extravagant technical curriculum. But it remains. And, when medicine wakes up to the existence of biology and rediscovers a philosophy, the genetic individual will be restored to his place.'

The medical and dental professions are not the only would-be students of man who are still at fault. The theories of psychiatrists, social anthropologists, religious teachers, and the founders and propounders of political doctrines have, of necessity, ignored genetic individuality. But so have other branches of dentistry to a greater extent than in orthodontics; the result has been increasing specialization based on empiricism and the elaboration of techniques. As orthodontists are less at fault they must continue to press for a greater role in undergraduate teaching because our knowledge of genetic individuality eliminates empiricism and will link all branches so that dental surgery will again be one subject. Much of such teaching should be preclinical.

However, in orthodontics the development of philosophies which ignore (or appear to ignore)

genetic individuality has consequences which are costly and time consuming when treatment is being provided as a social service free to all. It can lead to the elaboration of techniques as treatments relapse, on the old principle that if one fails to achieve an ideal occlusion it is the technique that is at fault. Research associated with these philosophies purports to show that such treatments change the individual characteristics. As a rule, the evidence produced is not scientifically selected with adequate control material, but appears to be satisfactory because it subconsciously selects minor changes of pattern in growth, genetically determined, as being appliance induced.

Prior to the formation of the Eastman Dental Hospital as a Postgraduate Institute in 1948, a combination of the study of the biological background to our problem, initially stimulated by the Brash Dental Board Lectures; the research in America, of Brodie in particular, on skeletal patterning, and our own attempts to change the skeletal pattern with functional appliances and muscle exercises, produced the conviction that the main aetiological factor in orthodontics was genetic individuality, and this was what determined success or failure in treatment.

When the Institute was formed it was decided to endeavour to keep full records on every case and follow through as many years out of retention as possible in order to eliminate empiricism in orthodontic treatment. The problem, however, has been that of applying statistical analysis to our observations of soft-tissue posture and behaviour. Professor Harris (1947) in his first Northcroft Memorial Lecture, criticized the rather artificial system of reference points and axes chosen for the convenience of measuring height, length, etc., for comparison and the study of growth. He suggested the use of co-ordinate mapping methods. We have now reached the stage when such co-ordinate analysis (Vig, 1967) can be applied to produce statistical proof of some clinical observations that will be presented to you later. However, because such statistical proof is not yet available, I wish to

state briefly the biological background as I see it and the development of clinical concepts from the study of the Eastman and Institute serial material.

The genetic individual developing in a normal environment owes his morphologic characteristics to the inheritance of shape or form of some structures. However, as Huxley (1953) said, some structures have adaptive properties and appear to simulate the inheritance of acquired characteristics. Connective tissues and joints are adaptive so that inherited patterns of bone and muscle can be co-ordinated to produce an individual fit to survive. The alveolar processes are adaptive to the imbalance of very light pressures. I shall be saying more about this later. Because the alveolar processes are adaptive a study of their soft-tissue environment appeared to be essential for our understanding of the aetiology of malocclusion and the elimination of empiricism in treatment planning. The development of concepts in this field is illustrated by the many papers published since 1947, at which stage as the result of attempts to re-educate what were subjectively thought to be bad habits of posture, it was concluded that, in fact, certain patternings must be inherited and not amenable to such re-education (Ballard and Gwynne-Evans, 1948). The concept of the physiologic rest position of the muscles as developed by Brodie and Thompson (1942) in relation to posture of the mandible gave us a valuable clue as to the way in which to study the soft-tissue environment of the alveolar processes (Ballard, 1953). It is now certain from an overwhelming amount of evidence that the rest position of the muscles of facial expression are at least laid down early in life and not amenable to change by any methods so far used. The result is a pattern characteristic of each individual. It is the pattern of the rest position of the muscles attached to the mandible which determines what we now define as centric jaw relationship. It is to this relationship that joints adapt. However, working on these bases, observations over a period still did not result in anything really conclusive, until it was appreciated that it was instinctive for each individual to produce a seal pattern of the soft-tissue environment of the anterior part of the upper and lower arches (Ballard, 1953). If such a seal did not come about with the muscles in rest position then adaptive postures with muscles continually contracted were instinctively produced and maintained (Ballard, 1955). As has been reported the incompetent lips of resting muscle either resulted in a sustained circumoral contraction to hold a lip seal or else a seal produced with lips apart, but with the lower lip elevated to contact the upper incisors. Because in the past postures in rest position and habitual postures have not been distinguished, I now prefer to refer to

muscles in the rest position as being in the relaxed position (Joseph, 1960). Muscles holding habitual postures are isometrically contracted by comparison with the relaxed position. The former has detectable electric activity, the latter does not. Analysing tongue posture on the same basis it has been demonstrated that there is a relaxed position and a reflexly produced and maintained seal posture (Ballard, 1959). The seal posture is with the tongue in the gap between upper and lower incisor teeth and spreading laterally to seal off the floor of the mouth. In association with certain morphological features the tongue and lower lip make contact between the upper and lower labial segments in the adaptive seal posture. It must now be admitted that a preoccupation with tongue thrusting delayed our appreciation of the true significance of the circum-oral muscle effort seen in swallowing under such circumstances. It is not due to an inherited activity of the tongue, an acquired bad habit, it is associated with the condition of lower lip and tongue contact in the production of an anterior oral seal, an adaptive habitual posture. As has been reported such tongue thrusting disappears when the tooth position with which it is associated is successfully treated (Ballard, 1962). There is no doubt that there are cases of endogenous tongue thrust, but they are relatively rare. To all intents and purposes tongue thrusting as an aetiological factor in the production of malocclusions can be ignored.

To return to mandibular posture, again we have no evidence that the patterning of the muscles which determines centric jaw relationship can be changed by any form of treatment. It is now evident that some mandibular positions are instinctively produced habitual postures to assist in the production of an anterior oral seal in certain types of malrelationships of labial segments. It is possible to induce some postures with functional jaw orthopaedics and with other forms of treatment by changing tooth relationships from one where such an adaptation is not necessary to one where it is, in which the mandible is postured forward. The claim can then be made that such a position is a new jaw relationship induced by the therapy. No claim to change jaw relationship can be accepted unless the researcher indicates clearly that he understands the concept of centric jaw relationship (Ballard, 1957).

The next step, which was associated with a correlated study of the articulation of the sounds of language (Ballard and Bond, 1960), was the appreciation that the adaptive postures just described arise on the principle of least effort. In other words they are sustained muscle contractions, the particular pattern arising on the basis of the least effort required to satisfy the instinct to produce a seal. It can be stated with some confidence that if, in the treatment of a Class II, division 1 incisor relationship, the retention of

the treatment requires a greater degree of sustained muscle effort than is necessary to maintain a seal of lower lip against the upper incisors then the treatment will relapse. This will be illustrated.

As far as skeletal pattern is concerned I have already referred to Professor Harris' criticism of the cephalometric methods which are still very much in favour. Brodie (1940) has shown that patterns remain remarkably constant. Brash (1924) suggested that environment could not change the form of the bones, and yet orthodontists occasionally produce evidence in support of claims that their particular therapy changes the pattern. What we now know from serial study is that there are changes in the individual patterning which are slight, and, I would suggest with confidence, not related to treatment planning. For instance as far as postnormality of mandible to maxilla is concerned, some improve, some get worse, but as I hope to demonstrate as far as tooth positioning is concerned, if it improves then it reduces the amount of tooth movement required, but not the character of the tooth movement required; however, the important thing is that because the relationship between artificial reference points and axes changes slightly, it is possible to demonstrate by the selection of suitable reference points and lines that apparently one can achieve changes in almost any direction according to the particular philosophy in which one believes.

Finally, in this summing up of the present understanding of the problem I return to the adaptive alveolar processes. In 1963 I said that our study to date had produced the conclusions that it is form and behaviour of the lips superimposed on the dental base relationship which are the primary factors in determining labial segment position, and only secondarily does the tongue by its adaptive behaviour mould the labial segments against the lips. The long-term follow-up of cases treated empirically demonstrated that the lower lip certainly controlled the position of the lower incisors. If proclined against it they relapsed, and if retracted from it they were moulded back to it by the tongue. This was so clearly demonstrated over ten years ago that treatment was so planned that no force was applied to the lower arch which might bring it forward unless space was present. The result was the increasing use of extra-oral anchorage and the extraction of lower first premolars. Some statistical analysis has recently confirmed these clinical observations (Mills, 1964 and 1966).

Last year (Ballard, 1966) in reviewing the clinical evidence associated with the adaptive properties of the alveolar processes I said that we must now accept Friel's view (1926) that it was static function which moulded the dental arches in their position of linguo-facial balance and not dynamic function. In other words, it is the

habitual posture of the seal patterns just described. In support of this I pointed out that in at least eighteen years' research using various techniques of increasing refinement, to analyse the forces of lips, cheeks, and tongue during swallowing, chewing, and speech, little or no evidence of clinical significance had been produced. Fletcher (1963a, b) in his extensive serial study has demonstrated how the general direction of growth of the labial segment alveolar processes is determined by this moulding activity early in the child's life, and not dependent on the eruption of teeth.

In the same paper I discussed the occlusal position within the inherited pattern of the intermaxillary space. A review of clinical evidence led to the conclusion that it was most probably a property of the mandibular cheek teeth alveolar process which determined the occlusal level, and therefore at the same time the angulation of the occlusal plane to base planes. Only secondarily did the maxillary alveolar process adapt to produce an occlusion in contact with the mandibular dentition, at the now accepted relationship to endogenous posture (interocclusal clearance, freeway space). It was pointed out, however, that the lower incisor and canine alveolar process must be excluded from this particular feature in that it will develop vertically as an adaptive property until such development is resisted by occlusal contact either with the upper incisors, palatal mucosa, or the under surface of the tongue. If the lower incisors and canines are not included in the occlusal plane or line in orthodontic cases, then serial study supports the original findings of Brodie, Downs, Goldstein, and Myer (1938) that in therapy changes of relationship to base lines of maxilla and mandible are only temporary.

For the purpose of serial study, therefore, the occlusal plane should be taken to be through the occlusal contact of premolars and molars, ignoring developing stages of molars when, temporarily, they are in a position of exaggerated curve of Spee. There are two more points of clinical significance. The first is that in ideal or near ideal occlusions such as seen in Eskimos, or Australian Aborigines, etc., the incisor occlusion is on the same line or occlusal plane of the cheek teeth as just defined (*Fig. 1*); the second is that our serial study shows that in every individual the occlusal line so defined bears a remarkably constant relationship to the adaptive seal profile of the lower lip, as seen in lateral skull radiographs. These relationships are the crux of the matter in determining whether or no a Class II, division 1 incisor relationship can be reduced to a stable position or whether it will relapse or require permanent retention.

Orton (1966) demonstrated how critical was the relationship of the upper incisors to the lower lip for stability of treatment and he referred to

the inner surface of the lower lip 'which is always inferior to the lip line'. I shall be referring to two aspects of the profile of the lower lip; there is, first, that of Orton, the inner surface, which makes contact with the labial surface of upper and lower incisor teeth. (Fig. 2; it is the profile below the upper arrow.)

Secondly, there is the upper part of the profile or lip line surface of the lower lip which as I

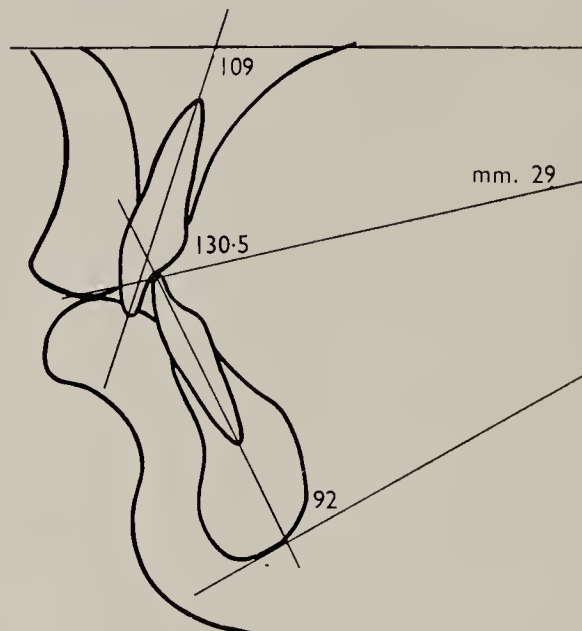


Fig. 1.—The relationship of normal overbite overjet incisor occlusion to the occlusal line.

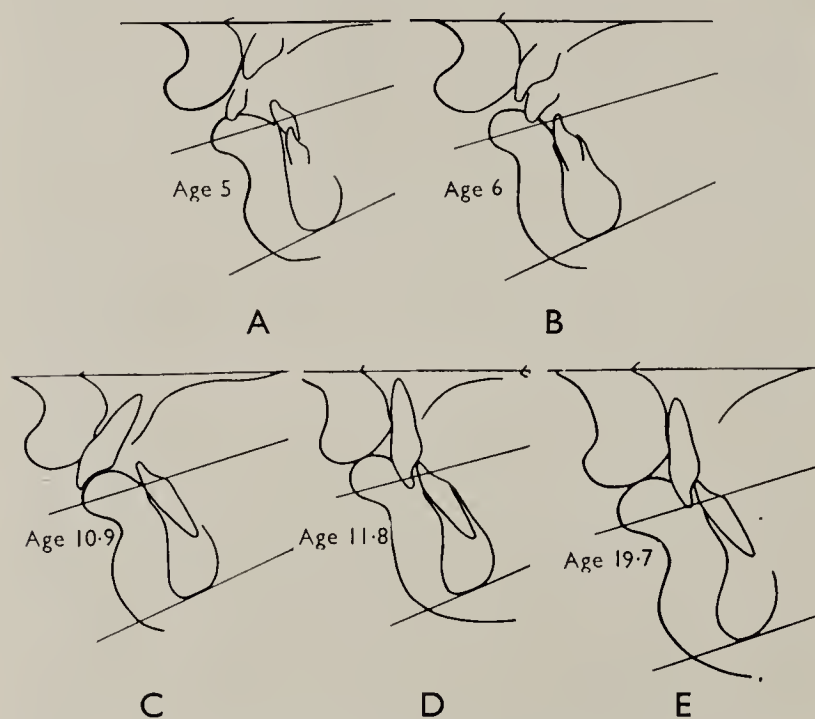


Fig. 3.—Tracings from serial skull radiographs of one individual showing development of a Class II, division 1 incisor relationship determined by lip morphology and relationship, and the constancy of the relationship of occlusal line to lower lip profile.

propose to demonstrate, only controls vertical development of the upper incisors and not their linguofacial positions. (Fig. 2; the profile above and in front of the upper arrow.)

Finally, in this assessment of the characters of genetic individuality it must be stressed that when talking about jaw relationship, as clinical orthodontists we are referring to dental base

relationship. It is very difficult or impossible to move the apices of teeth off the dental base and sometimes when we do, in particular when the upper incisor apices are through the labial plate, then root resorption may occur or lip pressure may produce relapse.

I am now going to illustrate the relationship between the inherited variations and the way in which they determine the position of upper and

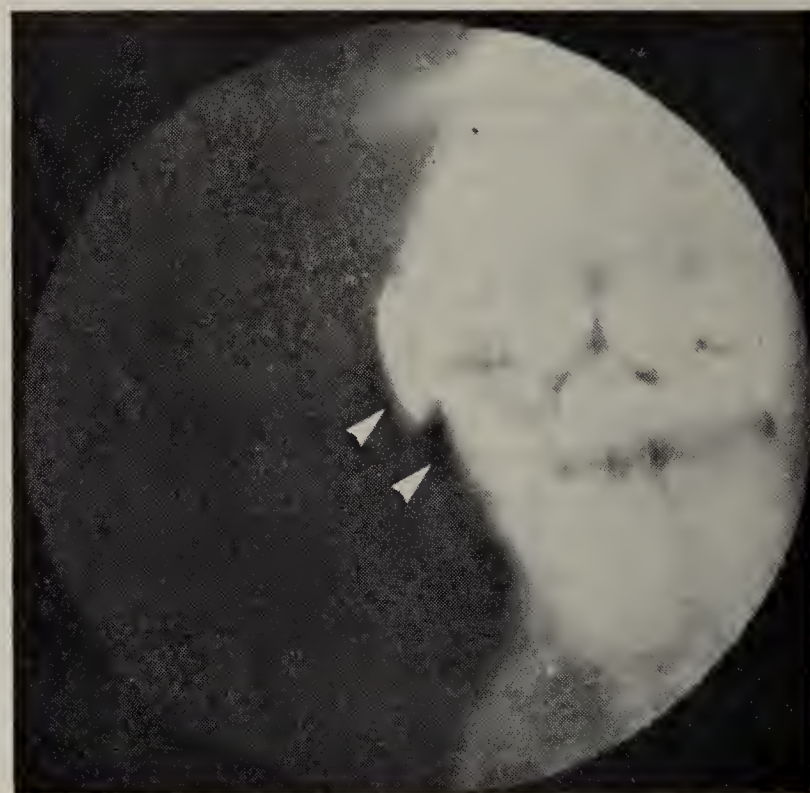


Fig. 2.—The inner surface of the profile of the lower lip is below the upper arrow; the upper profile above and anterior to the upper arrow (Orton, 1966).

lower labial segments, with particular reference to Class II, division 1 incisor relationship. At the same time I shall indicate the stable position within the inherited features. Following this are some cases that relapsed because of inherited features and some cases that relapsed owing to incorrect treatment.

Fig. 3 is the serial lateral skull radiograph tracings of one individual from the age of 5 years to 19 years 7 months. The lip morphology against which the labial segments have been moulded results in a Class II, division 1 incisor relationship, with the permanent teeth erupting along the line of the alveolar form. It will be noted through the series that the contours of upper and lower lips remain relatively the same and in particular the contour of the upper and inner surface of the lower lip in relation to the occlusal plane. Although the case was not treated correctly as labial bow retraction did not control upper incisor root position, the end-result remained stable because the inner contour of the lower lip when elevated to maintain a seal, covered more than half of the labial surface of the upper incisors. In its final position it had been taken upwards and backwards in relation to the occlusal plane, because in treatment the

lower labial segment had not been depressed. In *Fig. 3D, E* it will be seen that the upper incisors are away from the upper lip. Serial study by lateral skull radiographs suggests that the upper lip does not adapt to this retraction.

Fig. 4 shows three variations of relationship of lower lip profile to occlusal line and upper labial segment. *Fig. 4A* is a Class II, division 1 incisor relationship produced with a competent lip morphology and with the occlusal line cutting through the lip morphology above the lower lip. The lower labial segment and dental base relationship are postnormal to the maxillary dental base, such a statement being made by reference to the mean of *Fig. 1*. With such a combination of features complete reduction of the overjet will not remain stable because the upper labial segment cannot be put into such a position that the lower lip will hold it against the lower labial segment, even if the lower labial segment is depressed to the occlusal plane. The broken lines indicate the fully retracted position of the upper labial segment and vertically adjusted lower labial segment. The relationship is with the incisal tips of the upper incisors resting on the upper profile of the lower lip. This is not a retaining relationship. The upper labial segment will be moulded back to the upper lip. Such cases can be made aesthetically acceptable by changing

segment. It is even more evident than in *Fig. 4A* that the relationship of the retracted upper incisor teeth will be to the upper and not the inner profile of the lower lip, such a position not being stable. Finally in *Fig. 4C* the reduction of overjet

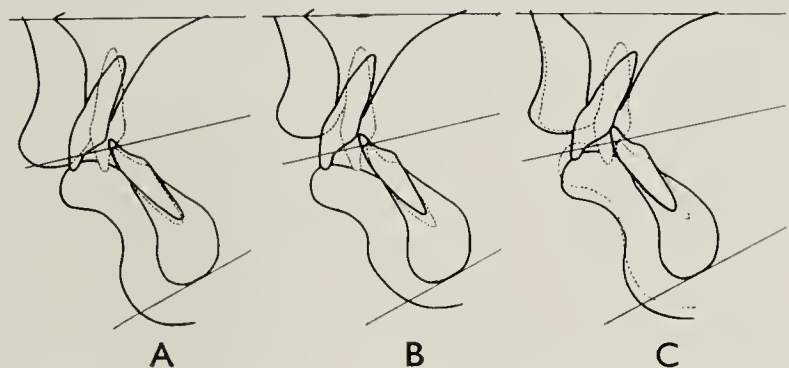


Fig. 4.—Three variations of relationship of lower lip profile, occlusal line and upper labial segment. A and B are not stable relationships in the treated position, represented by the broken outlines; C, stable relationship in the treated position, represented by the broken outline.

if the lower labial segment is depressed to the occlusal plane will remain stable, because the elevation of the lower lip to maintain a seal produces contact of the inner surface, and not the upper surface, with the labial surface of the upper incisors. Although a lip seal cannot be

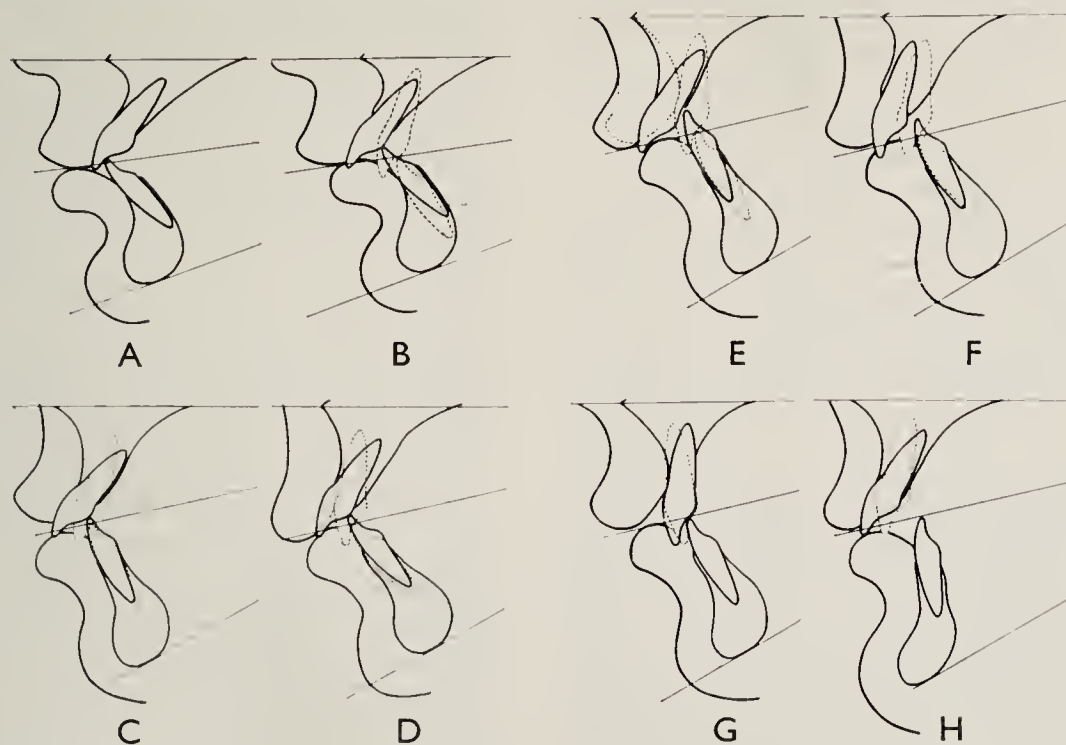


Fig. 5.—Variations of relationship of upper lip to lower lip and mandibular dental base to maxillary dental base on the anteroposterior plane.

the axial inclination of the upper incisor teeth within the general line of the alveolar process by bringing the apices forward a fraction on the dental base and taking the incisal tips back. *Fig. 4B* shows another combination of features which will result in a relapse. The lower lip is incompetent and in the illustrated position is elevated with sustained muscle effort to maintain a seal against the incisal tips of the upper labial

maintained (as illustrated) the new position of the labial segment will be retained by the lower lip.

The next set of variables (*Fig. 5*) are those of the relationship of upper lip to lower lip and mandibular dental base to maxillary dental base in the horizontal plane, such relationships between them determining labial segment axial inclination and the relationship of the lower

labial segment crowns to maxillary dental base. *Fig. 5A* is a typical bimaxillary proclination Class I incisor relationship showing a similar relationship of morphological features as in the mean of *Fig. 1*, the bimaxillary proclination being the result of the inherited morphology of upper and lower lips on a Class I dental base. *Fig. 5B* is near one extreme of variation of Class II, division 1 types which for convenience is labelled a bimaxillary proclination Class II, division 1. Stated simply, it is a bimaxillary proclination morphology of lips, but with a postnormality of mandibular dental base to maxillary dental base which results in the lower lip being postnormal to the upper lip. The occlusal line passes through the upper and lower lip contact line, but with the lower labial segment being in a position of excessive vertical development above the line because of the increased overjet. In such cases it will perhaps be evident from these illustrations alone that a mere reduction of the lower labial segment to the occlusal plane, and then a retraction of the upper labial segment, will not bring the crowns of the upper incisor teeth inside the inner part of the lower lip. What has to be done is illustrated by the broken outline. The lower labial segment has to be depressed with a change of axial inclination which swings the apices labially and the crowns lingually. The upper labial segment then has to be retracted using a technique which will prevent the apices moving labially, otherwise a rather unsightly Class II, division 2 incisor relationship is the result. It is unfortunate that such treatment of these cases as far as can be judged at present, although stable, is frequently not entirely satisfactory, in that both upper and lower labial segments are away from the upper and lower everted lips in the end-result and there tends to be an excessive 'dishing in' of the profile. However, experience suggests that any attempt to compromise will probably not remain stable.

Fig. 5C shows a fairly common type of Class II, division 1 incisor relationship in which the lower labial segment is in Class I relationship to the maxillary dental base but with the upper labial segment proclined because of the lip morphology. The treatment is to depress the lower labial segment and retract the upper labial segment until the crowns of the upper incisor teeth are inside the lower lip. The position of the apices can be permitted to change within the width of the alveolar process. With incompetent lips the end-result need not be maintained by a lip seal as long as the elevation of the lower lip in habitual seal position is sufficient to bring the inner surface in contact with the labial surface of the upper incisors.

Fig. 5D is a very similar labial segment relationship except that there is a postnormality of maxillary dental base to mandibular dental base, but a compensatory proclination of lower labial

segment as a result of a different lip morphology. Again the treatment is as simple as for the previous type.

Continuing the series, *Fig. 5E* and *5F* illustrate cases in which the lower labial segment is postnormal to the maxillary dental base and therefore multiband control of root position of the upper labial segment is essential if the best possible end-result is to be achieved. In *Fig. 5E* the upper labial segment is very proclined with apices distally placed on the dental base. This is a variation frequently seen. If the lower labial segment is depressed the upper labial segment should be retracted with axial inclination control which prevents the apices from moving labially. The upper labial segment has been moved away from the upper lip and put inside the lower lip.

Fig. 5F is another variation in which the central incisors in particular in such cases are so well forward against the labial plate that a greater degree of bodily retraction is required to produce the best end-result. In both types it is essential to depress the lower labial segment to the occlusal plane if the upper incisor teeth are to be put inside the inner surface of the lower lip, and so prevent relapse.

Fig. 5G illustrates a not infrequent finding in the long-term follow-up of severe Class II, division 1 cases. The solid line is the position of the upper labial segment when retention is discarded. Note again that it is the lower lip which is holding the upper incisors; as they are away from the inner contour of the upper lip, it is that contour to which they would relapse if the lower lip did not retain them. The fact that these incisor teeth are well inside the lower lip frequently results in the slight overjet being eliminated, with a forward swing of the apices as illustrated. This final tooth position is relevant to a discussion of Class II, division 2 types of incisor relationship.

Finally, in *Fig. 5H* there is illustrated a type of case which I previously described and which for want of a better all-embracing term we call 'an expressive behaviour Class II, division 1' (Ballard, 1963). In such cases one has the impression that the lower lip has a Class II, division 2 character in that it retracts in expressive behaviour. There are, however, two features which result in a Class II, division 1 incisor relationship; they are (1) a low lip line to occlusal line and (2) a greater degree of Class II dental base relationship than is usually found in Class II, division 2 cases (Ballard, 1956, 1963). The incomplete overbite is the result of the tongue in its adaptive seal position being forward against the upper labial segment, above the lower labial segment. The features which result in this relationship are probably as follows. First, the profile of the lower lip, the upper portion of which is everted. Secondly, the upper labial segment is held, as it were, on to this upper

portion by the upper lip which does not permit a great degree of proclination. Thirdly, and perhaps most important, is that the lips are very rarely incompetent and the lip line or lip contact level is below that of the occlusal plane of the cheek teeth. The upper labial segment in such cases can very rarely be retracted to a position

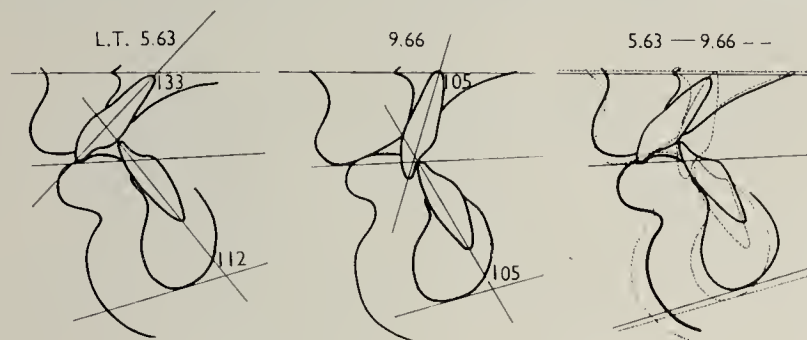


Fig. 6.—A bimaxillary proclination Class II, division 1 incisor relationship, before treatment, after treatment, and superimposed on occlusal line and on a perpendicular through maxillary planes.

inside the lower lip and would look unsatisfactory if so treated. The treatment is a retraction of the upper labial segment with a labial movement of the apices and a lingual movement of the crowns. This change of axial inclination, particularly if associated with a reduction of crowding, remains stable. It is not a change of the general line of the alveolar process. The tongue to lower lip habitual seal posture should still be present after treatment.

The next three cases are severe Class II, division 1 which in my view can only be treated satisfactorily with multiband techniques used to control root position.

The first case, L.T., (Fig. 6) is a bimaxillary proclination case treated satisfactorily with edgewise and incidentally, non-extraction, which necessitated prolonged extra-oral anchorage. It will be seen that the lower labial segment has been retracted and depressed, the change of axial inclination being from 112° to 105° , and such a position remaining stable probably because the axial inclination of the teeth only has been changed and not the general line of the alveolar process. The upper labial segment has then been retracted with control of root position, the end-result being stable because the upper incisors although away from the upper lip are inside the inner profile of the lower lip. The essential features of the treatment of this type of case were not known until edgewise arch therapy used according to Tweed's philosophy (1945) had been applied to several cases.

The second case, Case T., (Fig. 7) is one in which the lower labial segment is severely postnormal to the maxillary dental base and in which the lingual cortical bone is a limiting factor. Even with multiband control of the root position of the upper labial segment the palatal

contour prevents sufficient lingual movement of the upper labial segment, so that a good axial inclination relation of upper labial segment can be produced with the crowns of the teeth inside the lower lip, occluding with the depressed lower labial segment. The stable end-result is maintained by the elevated lower lip to maintain a seal

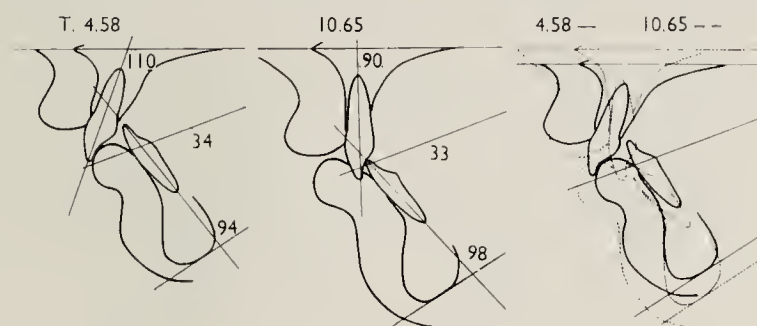


Fig. 7.—A Class II, division 1 incisor relationship before and after treatment and superimposed on occlusal line and on a perpendicular through maxillary planes.

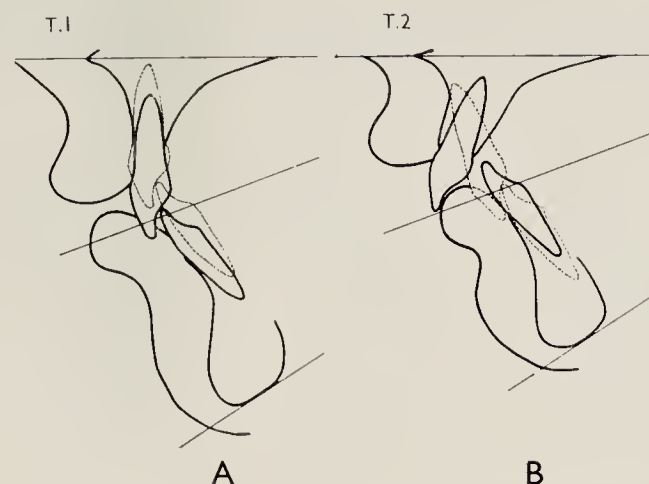


Fig. 8.—The same case as Fig. 7; represented as incorrectly treated. A, Without depression of lower labial segment to occlusal line, upper labial segment not under control of the lower lip. B, Lower labial segment depressed to occlusal line, but labial segment retracted without root position control.

which is still not maintaining a lip seal. The superimposition on the right is on occlusal lines orientated on a perpendicular from maxillary line. Note the constancy of relationship of occlusal line to lower lip contour.

Fig. 8 illustrates two possible maltreatments of the last case (Case T.). Failure to depress the lower labial segment would have resulted in a retraction and depression of the upper labial segment both in relation to the profile of the lower lip and the occlusal plane. The upper labial segment would then not have been retained by the lower lip and would have been moulded back to the relaxed position of the upper lip. Fig. 8B illustrates the kind of result that is frequently achieved with any appliance which does not control root position when there has been successful depression of the lower labial segment to the occlusal plane. Furthermore, it must be said that the greater the retracting force

(not physiological) the poorer the end-result. This can be expressed quite succinctly (Fletcher, personal communication): 'The greater the pressure you apply to the labial segment without torque control the lower down the root is the pivotal point.'

Finally, in this series of satisfactorily treated cases, I illustrate a comparatively rare type of

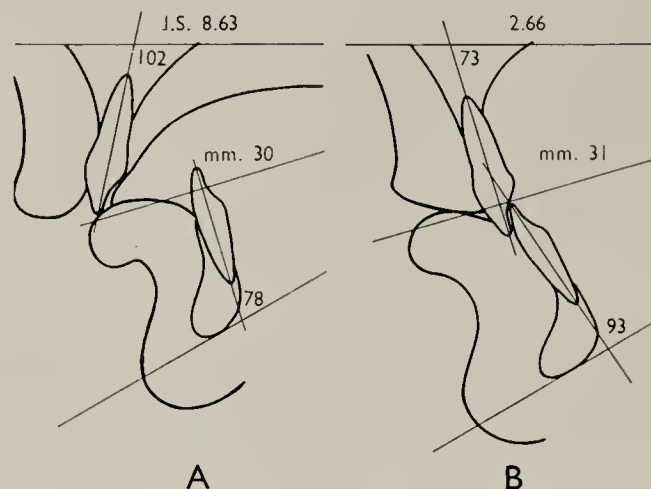


Fig. 9.—Type of Class II, division 1 in which proclination of the lower labial segment will probably remain stable.

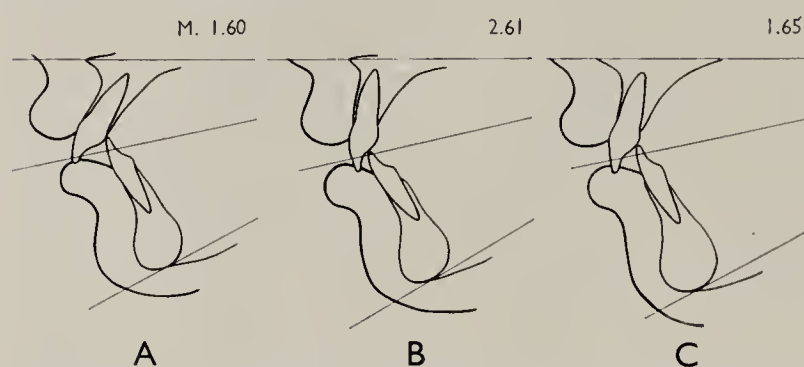


Fig. 11.—Class II, division 1 incisor relationship associated with a relationship of lower lip to occlusal line such that the fully retracted upper labial segment will not remain stable. C, Relapsed stable position.

case (Case J.S.) (6 in 1000 Class II, division 1; Mills, 1965) in which proclination of the lower labial segment is a justifiable thing to do (Fig. 9). Such a case was first illustrated in 1953 (Ballard and Walther) although the authors at that time did not appreciate the special feature which has to be present if the case is not to relapse. It will be noted that in Fig. 9A the relationship of the lower labial segment is firstly relatively retroclined and the labial surface of the lower incisors faces a nearly vertical aspect of the palatal mucosa. When there is such a relationship between lower labial segment and the inner contour of the upper labial segment, more particularly if there is a related digit-sucking habit, it is thought that the seal position of lower lip has a retroclining action on the lower incisors, but not so much on the alveolar process. If this is not a satisfactory explanation then all that one can state is that the features as described are those which are associated with the very few cases in which proclination of the lower labial

segment has remained stable. Even with proclination of the lower labial segment the upper labial segment has to be retroclined in order to put it inside the lower lip because of the limitations imposed by the palatal dental base profile. In other words, the occlusion has been turned from a Class II, division 1 incisor relationship into a Class II, division 2.

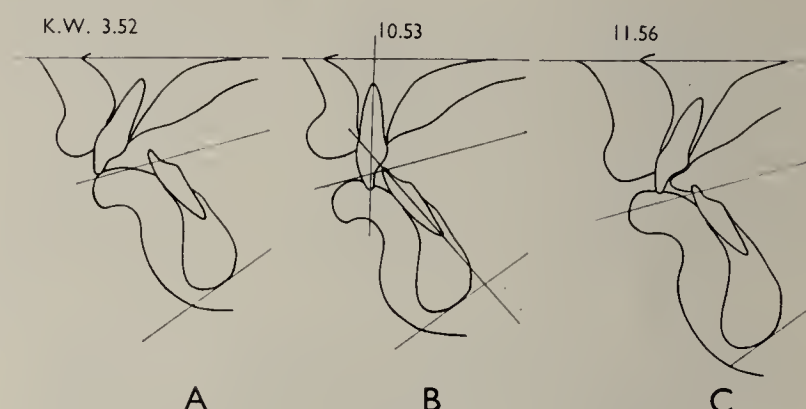


Fig. 10.—Class II, division 1 incisor relationship associated with a relationship of lower lip to occlusal line such that the fully retracted upper labial segment will not remain stable. C, Relapsed stable position.

The next two cases have morphological features which would not retain a stable reduction of the overjet. In the first case (Case K. W.) the tracing in Fig. 10A illustrates the dento-alveolar position before treatment with the tongue and elevated lower lip maintaining a seal. In Fig. 10B the occlusion after the lower labial segment had been depressed and the upper labial segment retracted to the lower labial segment, the elevated lower lip maintaining a seal because its upper contour contacts the incisal tips of the incisor teeth. This is a quite inadequate relationship to retain the upper labial segment and the result is that the tongue moulds it back to the relaxed position of the upper lip. Such a relapse has to be accepted unless permanent retention is considered justified; as a rule it is not. Fig. 10C shows the stable relapsed position.

The second case, Case M. (Fig. 11), is similar except that there is a slight difference of the profile of the lower lip in relation to the occlusal plane. The upper portion of the lower lip is shorter, but the inner and more vertical portion which has to control the position of the upper labial segment is well down the lingual profile of the lower labial segment when the lower incisors are in the correct relationship to the occlusal line. Again, this case relapsed, as seen in Fig. 11C, and again permanent retention would not be justified.

The next two cases show relapse because the treatment was incorrectly planned and carried out in relation to morphological features. In the first case (Case C.O.) (Fig. 12), the overjet was reduced as in Fig. 12B, but the reduction was not related to the depression of the lower labial

segment to the occlusal line. This resulted in a failure to produce a retaining relationship of upper labial segment to the lower lip and the case relapsed. *Fig. 12D* illustrates what should have been done. In such treatment multiband is required in that the lower labial segment has to be retracted with such control of root position that the apices are taken slightly lingually.

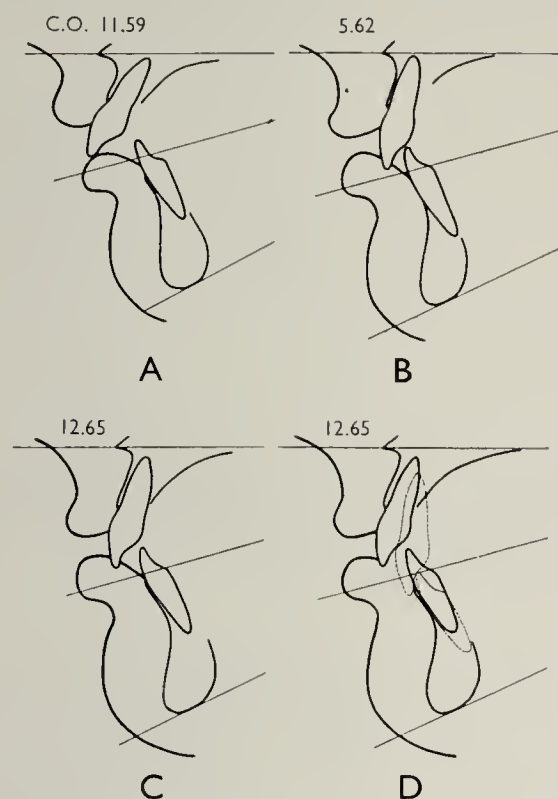


Fig. 12.—Class II, division 1 incisor relationship the treatment of which was not successful. The reduction of the overjet did not remain stable because the lower labial segment was not depressed to the occlusal line. D, Broken lines show tooth positions as they should have been produced by treatment for stability of end-result.

The second case (*Case D.F.*) (*Fig. 13*) was lip competent with a high lip line in relation to the occlusal plane, but again would most probably have remained stable if the lower labial segment had been depressed and retracted such that the upper labial segment could be retracted with control of root position, the crowns being put inside the lower lip as illustrated in *Fig. 13C*. This case has an element of alveolar process proclination in the lower lip morphology. It will be noted that in the treatment, which was incorrect, the slight depression of the lower labial segment had been associated with a slight proclination. As illustrated in *Fig. 13C*, it should have been depressed and retracted.

Fig. 14 illustrates the last Class II, division 1 case (*C.*). It shows many features which are all too common in cases treated with removable appliances. There has been failure to depress the lower labial segment. The retraction of the upper labial segment has been incomplete, it was without control of root position and therefore the apices were brought outside the contour of the labial plate and there was root resorption. The case remained stable in this position because

the lip seal position of the elevated lower lip brought the inner profile into a stabilizing position. A point I should emphasize here is, however, that as we originally traced the labial plate for a determination of point A, the profile had been drawn on the flare of bone out to the anterior nasal spine, which is readily seen most clearly when a Björk wedge is used. It is fre-

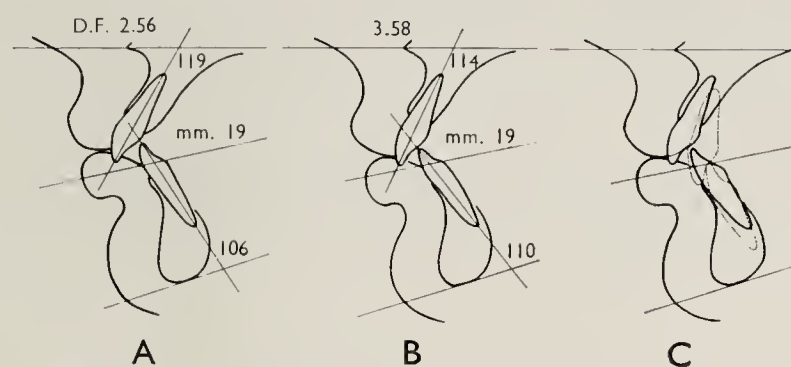


Fig. 13.—Class II, division 1 incisor relationship the treatment of which was not successful. The reduction of the overjet did not remain stable because the lower labial segment was not depressed to the occlusal line.

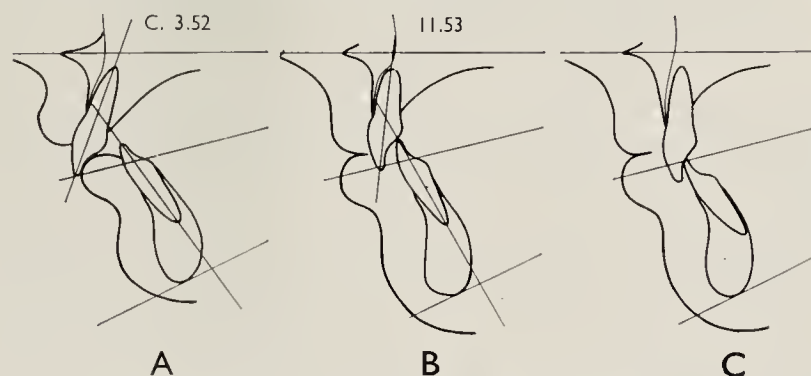


Fig. 14.—Illustrates two important failures of tooth positioning in Class II, division 1 incisor relationship. B, (1) Failure to depress lower labial segment; and (2) Lack of root position control of the upper incisors. C, Tooth positions that should have been achieved.

quently only when roots are brought outside the true profile of the labial plate that it is evident where this is. The correct treatment in this case would have been the positioning of the teeth as in *Fig. 14C*.

Briefly *Case G.D.* (*Fig. 15*) is a Class II, division 2 case to illustrate why more often than not they fail to respond to treatment. *Fig. 15A* shows the original position of the labial segments with a high lip line in relation to the occlusal plane, the upper labial segment being inside the lower lip; *Fig. 15B* shows the attempt to adjust the axial inclination of the teeth. It will be evident here that if the lower labial segment had been depressed to the occlusal plane and the upper labial segment adjusted to it, the prognosis would have been even worse. The case relapsed. *Fig. 15C* illustrates the case as seen many years later. The relationship of the upper labial segment to the inner contour of the lower lip does suggest that in borderline Class II, division 2

cases it might be possible to take the upper labial segment away from the influence of the lower lip and put it wholly against the upper lip with a permanent reduction in excessive overbite.

Finally, *Case A.N.* (*Fig. 16*) is a Class III case to illustrate that lip morphology and relationship does not enter into the treatment determination and that one is severely restricted to changing the axial inclination within the general line of the

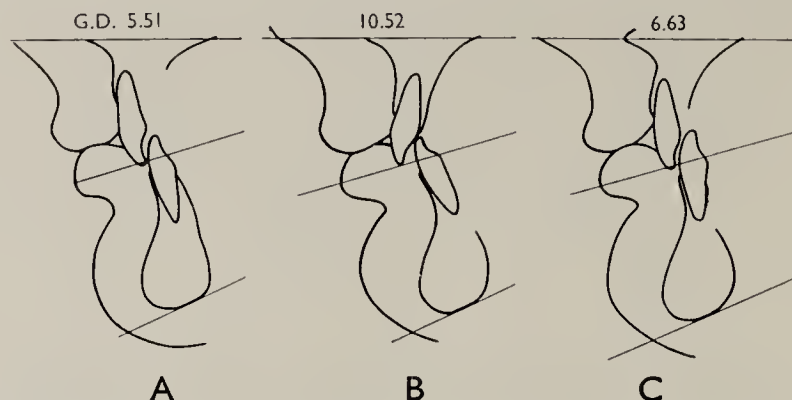


Fig. 15.—Shows relationship of upper incisors to lower lip and occlusal line in Class II, division 2 cases. The treated position of the upper centrals in the middle picture is still inside the lower lip and so relapse occurred.

alveolar processes. If this will not result in a stable tooth position without traumatic occlusion then orthodontic treatment is not indicated, but surgery may be.

It will be appreciated that I have said very little about the upper lip. This is in fact because as far as my observations go to date there is little to be said. I have not been able to convince myself that the upper lip plays any part in stabilizing the treated Class II, division 1 incisor relationship. Occasionally, individuals who are mildly incompetent before treatment appear to maintain a lip seal after treatment. The habitual pattern being maintained with some contraction of the muscles of the upper lip, as previously illustrated. In such cases I would suspect that when not being observed the upper lip relaxes and the lips part slightly. This detail requires further investigation. The important feature for stability of treatment, however, is the relationship of lower lip to the upper incisors and not the upper lip posture.

I have said that statistical proof of the observations just put to you requires time-consuming multivariate analyses. There are now so many cases available reasonably documented that computer analysis would be essential. However, clinical support is readily obtainable by any orthodontist. It has been obtained on the cases at the hospital in my hands. About 12–13 years ago I accepted the principle that the alveolar processes were adaptive and had to be permitted to adjust to the position of linguofacial equilibrium. An attempt was made to discontinue the use of retainers. More often than not occlusions settled down very satisfactorily. Some,

however, began to relapse and retainers were inserted. It is now possible to predict from the analysis of genetic individuality exactly what will happen with no retention immediately after active treatment. This, in my view, is the strongest possible support for the statements made in this paper.

To summarize this aspect, the alveolar processes are adaptive, the soft-tissue environment is

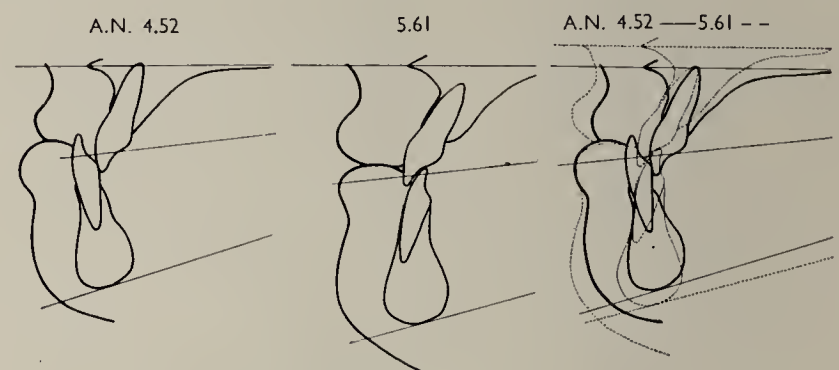


Fig. 16.—Class III case, lip morphology and relationship to lip line and to occlusal plane are not important features. The change of axial inclination is important.

not. It is practically impossible for an orthodontist however skilled to put the dental arches exactly in the position of linguofacial balance, therefore even after prolonged retention adjustments by physiological tooth movements will take place. Why not dispense with retainers and let this adjustment occur almost immediately after active treatment? There are some few exceptions in that permanent retention may be justified in severe Class II, division 1 cases, as bite plates in Class II, division 2 cases, and as a prevention of traumatic occlusion in the treated Class III cases.

In conclusion, I would like to say that I think orthodontics in this country is now at the crossroads. We have reached the stage when studies of genetic individuality enable us to determine the exact causes of the positioning of the dento-alveolar processes and to decide as the result of such analyses where the teeth can be put by treatment to improve appearance and function. This exact determination eliminates empiricism.

The outcome of the analysis as advocated determines the type of tooth movements required and therefore the type of appliances necessary to produce such tooth movements. Adequate epidemiological studies have not been concluded yet, although I know they are being done, and I am hoping that Professor Tulley, who will open the discussion, will have some information for us. It is reasonable to suppose, however, that as inherited variations are distributed in the population in the normal way, then, for instance, the majority of Class II, division 1 malocclusions would probably fit into the category of being easy to treat with simple removable appliances; however, the more extreme, but fewer, cases on

the curve of normal distribution undoubtedly require multiband techniques. There is an increasing interest in this country in such techniques, one hopes, because, in fact, they are essential for the treatment of certain types of cases. In my view it would be disastrous for the future of the service in this country if the fashion became the exclusive use of multiband appliances, because such a change would most probably be related to the philosophies current at the moment in which genetic individuality is almost completely ignored. The main aim of such philosophies being the elaboration of techniques so that every individual can be reduced to a subjectively assessed norm. Television makes it possible to see close-ups of individuals treated to these norms. It is my view that many people who have had such treatment, either by orthodontics, oral rehabilitation, or prosthetics, have poor facial aesthetics because the 'normal' occlusion does not fit the resting position and expressive behaviour of the soft tissues. Therefore, except in a few cases in which permanent retention might be justified, it should be our aim to reduce the malocclusions towards the mean, one might almost say the aesthetic mean, for the ethnic group, the end-result being stable without retention and therefore still fitting the features of the individual.

Opponents of social services would probably criticize this as compromise treatment necessitated by our health service. Such criticism is almost as ridiculous as the assumption that all individuals who are outside 2 S.D. from the mean for height are pathological and should be treated. I think we can say that we are looking at the problem biologically and ignore such criticisms. However, we shall not be able to ignore criticisms if we allow our health service to force compromise treatments on us because multiband techniques are too time consuming even when required, and therefore it is essential for the future of the service that all graduate teaching includes instruction in techniques which permit complete control of tooth position as required by genetic individuality.

Acknowledgements

It will be evident that for the sake of brevity it has not been possible to give due recognition to all those colleagues with whom discussion and criticism has been invaluable and whose treatment of patients has contributed to the concepts expressed

today. Such a list would commence with our President, Mr. Hooper, who, with myself and Professor Tulley, Mr. Hovell, Mr. Gwynne-Evans, Miss Van Thal, Mr. Rix, and Professor Whillis, formed a study circle in the immediate post-war years. This started minds working again.

In more recent years I am particularly indebted to Mr. Halden whose aim at perfection made him adopt the edgewise technique, take the Tweed course and then apply the Tweed philosophy to cases whose treatment had previously eluded us.

Finally, I am indebted to the tracer, Mrs. Flatman, for the excellent tracings, and to Mr. Morgan of our Photographic Department. I am also indebted to Mr. Orton for permission to use *Fig. 2*.

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DISCUSSION

Professor W. J. Tulley said that it was a great privilege for him to open this discussion.

He was merely here to add a little epidemiological aspect to it, at the author's request. He had found from a survey of 1500 schoolchildren aged 11 years that only half of those put in the category of Class II,

division 1 required any treatment at all. Of those left out, half the cases had a very very mild Class II relationship which was aesthetically and functionally quite acceptable. Secondly, with regard to this over-preoccupation with tongue thrusting, it was found that only 0.6 per cent of the total population

sample had a tongue thrust of the type felt to be a problem and which might be labelled endogenous.

With regard to cephalometric studies, he was glad of the author's comment, particularly in relation to the use of the A and B points, those fictitious areas which could so easily be changed that they were quite unrelated to dental base relationship.

The real core of the lecture had been in relation to the prognosis for stability, and the author had shown the difficult cases where root control was essential.

He had not been able to give precise figures for these numbers in the population sample. It was found that about 20 per cent of the subjects had Class II, division 1 malocclusion, and of those only half required treatment, so that made 10 per cent of the total sample. He had assessed that only 2.8 per cent of the total sample who had Class II, division 1 type malocclusion really required specialist treatment. Of that 2.8 per cent (which represented 13 per cent of the Class II, division 1 cases), less than half would have come into the category of the type of problem Professor Ballard had been describing.

In conclusion, Professor Tulley emphasized the point made by the author at the very end; that it would be disastrous for the future of the service in the country if the fashion swung away from the use of removable appliances for the most common type of Class II, division 1 treatment.

Professor Ballard thanked Professor Tulley for producing the figures, which had really put the whole thing in proper perspective.

Mr. P. H. Burke asked whether Professor Ballard would be good enough to define his occlusal line clearly, and whether he had carried out any double determinations on the accuracy with which he could put this line in place. Its importance was in its relationship to the lower lip contour, and this was at the far end of the line, so that any inaccuracy in angulation would be accentuated.

Professor Ballard said that he had an adjustable set-square and put the radiographs up on a viewing box. He then put the upper arm of the adjustable set-square through the maxillary line, which did not necessarily go through the anterior nasal spine. He put the other arm through the shadows of the occlusion of upper and lower premolars and first molar or first and second molars, according to the stage of development. It might be said that this was not a very accurate way of doing it, but the interesting thing was that if the adjustable set-square were then screwed up to hold that angle, it fitted the series of radiographs all the way through the development. If one then altered that angle one degree above or one degree below and went through the same procedure, they would not fit at all, so that it was accurate within one degree change of angulation. Having set the set-square, one could go through these quickly and relate the occlusal line to the lower lip in the series of any one case.

He had not time to do the enormous amount of multifactorial analysis. These were his clinical observations and he was hoping that from now on

others would make these analyses. But he was fairly satisfied about the accuracy of this occlusal line.

Mr. C. D. Parker said that he realized that, for the purpose of illustration, it had been necessary to show lateral skull radiographs. Were lateral skull radiographs a help or was a clinical examination just as accurate. What degree of accuracy was there in detecting difficult cases.

Professor Ballard, in reply, said that he thought it was, with a little bit of experience.

Another thing originally in the paper was a discussion of the difficulty of recording habitual posture, and this was one of the reasons why it had taken so long to tumble to this comparatively simple answer. If one put a child in a cephalostat and said, 'Close your teeth', it would either go to one extreme and retract upper and lower lips into a snarl position. Associated with this the tongue is retracted into the floor of the mouth. Or else the lips would be pursed and the tongue thrust into the roof of the mouth. Both were extremes of normal patterns of behaviour, and it was very difficult indeed to record habitual postures, but it had to be done if they were to prove all he had said today; so that in fact what he had to do was to relate all the serial material they had, and this included photographs, skull radiographs, and descriptions of soft-tissue morphology to determine habitual postures. If habitual posture could be recorded in a lateral skull radiograph it was then only necessary to look at it and determine the prognosis of the case. With a little experience it was as straightforward as that.

Mr. L. H. Russell asked whether it would be worth taking lateral skull studies in a relaxed position or whether they should all be taken in a teeth-together position.

As a practising clinician he hoped that teachers and researchers would put some effort into looking for appliances which could be used to actively depress lower incisors of removal type and possibly get apical torque without the use of fixed appliances. There were appliances which clinically seemed to give this effect by the use of opposing springs at different levels on upper incisor teeth.

Professor Ballard, referring to lateral skull radiographs, said that he believed that every individual who reached adulthood ought to have a lateral skull radiograph taken in occlusion to record his vertical dimension, and then the prosthetists would not have to take their horrible instrument and push it up under the nose and measure the height of the occlusion.

He was not so sure that for normal work this lateral skull radiography was necessary. He believed that if one began to look at the habitual posture of the lower lip and related it to the occlusal plane of the cheek teeth clinically, this would be sufficient to determine the prognosis.

With regard to appliances, this problem of depression of teeth was a difficult one, particularly concerning lower incisors. It could be done with bite plates, but the right way was to apply a continuous light pressure, and how that could be done with a removable appliance he did not know.

INTRA-ORAL BURNS

DENIS GLASS, L.D.S. R.C.S., D.D.O.

Orthodontic Consultant, Queen Victoria Hospital, East Grinstead, Sussex

ELECTRIC burns of the mouth usually occur in children under the age of 4 years, and, according to Fogh-Andersen and Sorensen (1966), occur twice as often in boys as in girls.

The incidence and treatment has been fully described by various plastic surgeons, including Thomson, Jukes, and Farmer (1965) and Hyslop (1957). The usual cause is a live electric

The entire hard palate was scarred and its posterior half was destroyed by the burn, producing a palatal fistula through which the nasal septum was visible.

The tongue was badly damaged being greatly reduced in size, and movement was limited by its adhesion to the floor of the mouth.

During these early years of life the effect of such severe intra-oral damage on the growth development



Fig. 1.—Photographs of the girl at 16 years of age. A, Side view; B, Full face.

plug on an extension lead, such as is used for electric kettles and vacuum cleaners, and in most of the accidents the bakelite of the plug has been damaged and the terminals are exposed. The degree of tissue damage varies from a mild burn of the lip to severe tissue destruction of the intra-oral tissues.

CASE REPORT

The case under review covers the period from 1 to 20 years of a girl who received a severe intra-oral burn from the lead of an electric kettle. The burnt areas included the lips, the cheeks, the tongue, and the hard and soft palate. The greatest problems arose from the contraction of these areas, which severely limited mandibular movement (Figs. 1, 2).

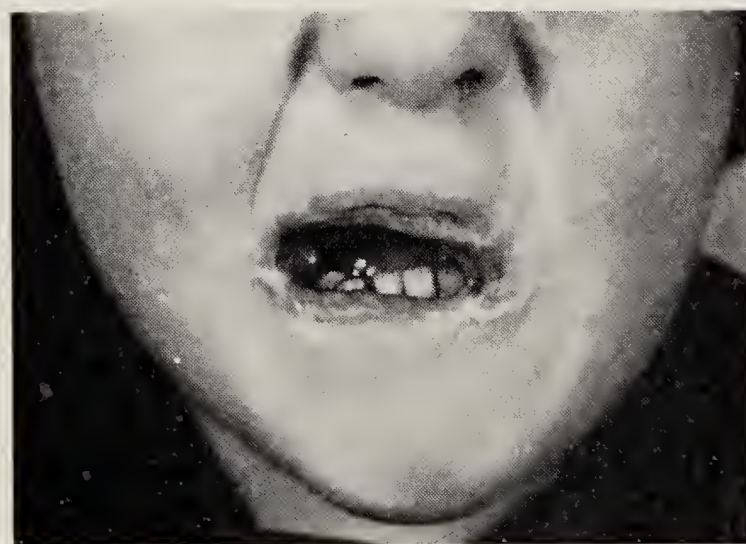


Fig. 2.—Mouth, showing maximum opening of the mouth, with limited mandibular movement.

Presented at the Country Meeting in Bristol on 14 April, 1967.

and function of the mouth and surrounding structures is of interest.

Speech was affected by the following factors:—

1. The lips being hard and immobile were unable to execute the movements necessary for labial sounds.

2. The tongue being reduced in size and tied down to the floor of the mouth was considerably limited in its movement during speech.

3. The oronasal fistula and the immobile scarred soft palate allowed the free entry of air into the nose, producing rhinolalia. This combination of disarthria and rhinolalia produced speech which at times was

real problem, as no ordinary tray could be inserted. Impressions were taken in plaster-of-Paris, and the handle of a spoon was found to be the best instrument to support the palatal plaster. The plaster was broken before removal and assembled outside the mouth.

The prosthesis to cover the palatal fistula had to be made as small as possible, otherwise it could not be inserted.

Owing to the lack of access to the mouth, the fluid diet and the inability to clean the teeth, the dentition rapidly deteriorated, and at 20 years of age only two teeth remained.



Fig. 3.—Models of the upper arch compared with a normal child of 9 years of age. *Top left*, at 4 years; *Top centre*, at 6 years; *Top right*, at 20 years. Note the contraction of the arch, and the increased size of the fistula at 20 years.

almost unintelligible and the passage of fluids into the nose and the constant dribbling added to the child's embarrassment. Furthermore, constant anxiety was produced by the gradual contraction of the scar tissue of the lips and the limited opening of the mandible which increased in intensity from year to year and made feeding impossible except by a fluid diet. This contraction of the circum-oral tissues had to be corrected by periodical skin-grafts to the areas concerned.

DENTITION

The gradual contraction of the lips so reduced the access to the mouth that dental treatment became a serious problem; no conservative treatment was possible as a handpiece could not be inserted into the mouth. Extractions were carried out when necessary; even so the removal of the teeth was made very difficult owing to the difficulty of access. The taking of impressions for a prosthesis presented a

Fig. 3 (*top left*) shows a model of the upper jaw at 4 years of age. The striking feature is the smallness of the maxillary arch in all dimensions and the contraction of the arch as the deciduous molars are approached. The fistula is evident between the two deciduous second molars, and being the area of greatest damage in the palate would account for the arch contraction in this area.

Damage to the nasal septum is also evident.

Fig. 3 (*top centre*) shows the maxillary arch at 6 years of age

The restricted growth of the arch is evident and the jumble of erupting permanent teeth can be seen in the incisor region.

There is no increase in width in the molar region, but it is interesting to note that the position of the fistula has moved backwards relative to the second deciduous molars. This is probably due to the forward movement of the entire dentition to accommodate the erupting molars.

Fig. 3 (top right) shows the mouth at 20 years of age, when growth is completed. All the maxillary teeth have been lost except the second permanent molars, which have been conserved by gold caps to assist with the retention of the prosthesis. Again, the smallness of the entire maxillary arch is evident. There is little increase in arch width as the second molar region is reached and yet these molars occupy

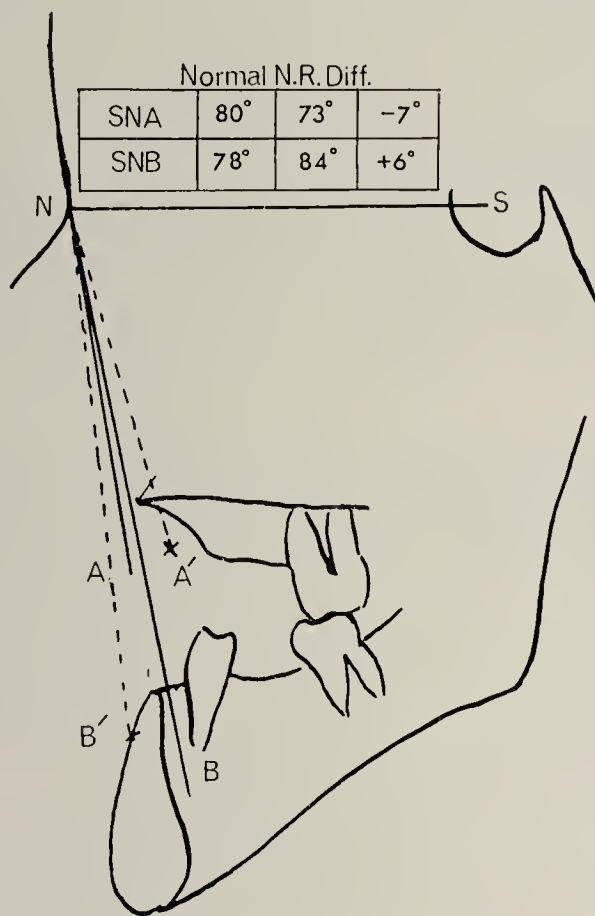


Fig. 4.—A lateral cephalometric tracing of the skull at 20 years. Angle SNA registers the degree of maxillary retrognathism, being 7° less than normal, while SNB, the mandibular register of prognathism, is 6° greater than normal. The skeletal base of the mandible is probably unaffected by the deformity.

the position of the second deciduous molars relative to the fistula. Another point of interest is that the palatal fistula itself has increased considerably in size during growth, this is the reverse of the fistulae found in congenital cleft palate cases, where the fistulae tend to become smaller with maturation.

The lower dental arch has contracted considerably with the teeth all lingually inclined. The skeletal bone, however, is probably unaffected.

It is interesting to note the effect that the scarred oral mucosa and the damaged palate have on the growth of the jaws. The area most affected is the maxilla, especially the hard palate and the maxillary dental arch.

Growth is deficient in all three dimensions, but lateral and anteroposterior growth are more reduced than that of vertical height. The deficiency in the vertical and anteroposterior growth of the maxilla produces a pseudo-prognathism which is further accentuated by the excessive free-way space, and the over closure when the teeth are occluded.

Fig. 4 shows a lateral cephalometric tracing of the skull at 20 years. Angle SNA registers the degree of maxillary retrognathism, being 7° less than normal, while SNB, the mandibular register of prognathism,

is 6° greater than normal. The skeletal base of the mandible is probably unaffected by the deformity.

Growth defect in width is well demonstrated from the study models.

Fig. 5 shows an anteroposterior cephalometric tracing with the head orientated in the Frankfurt plane. The upper part of the face is normal, but the contraction of the palate is well demonstrated by the

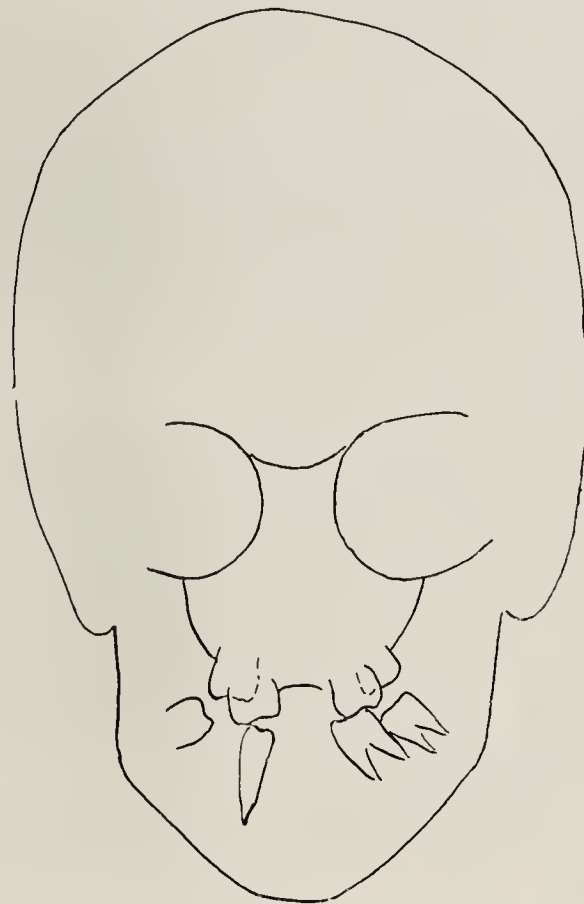


Fig. 5.—Shows an anteroposterior cephalometric tracing with the head orientated in the Frankfurt plane. The upper part of the face is normal, but the contraction of the palate is well demonstrated by the width between the second molars. The third molar region, however, is not nearly so contracted.

width between the second molars. The third molar region, however, is not nearly so contracted.

It is interesting to see the effect of severe damage to most of the intra-oral tissues at a very early age and to watch the growth and development of the face and mouth during the growing years.

It seems remarkable how localized is the effect of severe trauma. The skeletal part of the mandible and maxilla are not affected to the extent that might be expected, and the body has tended to localize the damaged tissues and produced near normal supporting tissues.

When this is compared with the average cleft lip and palate case it will be obvious how much more scar tissue contraction is to be seen in this mouth, yet the general growth and facial skeletal growth and development is good, which suggests that the great growth defects seen in congenital facial deformities are caused by factors other than surgery.

CONCLUSION

Although this case is of considerable interest from a growth study point of view, it is still a

great tragedy in the life of a child, and also for the parents. The degree of intra-oral mutilation was great and the effect on everyday life of the maturing girl was tragic, her poor speech, her inability to eat solids, the difficulty of retaining dentures and her constant dribbling combined with the external facial disfigurement of her mouth all combined to affect her outlook on life, while the problem of her future rehabilitation and treatment were becoming evident.

Many accidents of this kind could be prevented by ensuring that electrical extension leads are switched off at the wallplug and that the extension plug is made of unbreakable material, but still better that movable electrical appliances should

DISCUSSION

Mr. D. H. Oliver asked whether Mr. Glass had invoked the aid of the speech therapist and possibly the hypnotist in the case mentioned in the paper.

Mr. Glass replied that a speech therapist had been used. Needless to say, the plastic surgeons had had to operate on the child every three or four years to increase the aperture of her mouth, otherwise she could not eat. The speech therapist had done quite a lot, but the mechanism was so damaged that, at 20 years of age, the girl's speech was no better. There had not been any hypnosis.

Major W. K. Lervy asked for Mr. Glass's views on the early treatment of such a case in the light of his experience.

Mr. Glass replied that it was very rare that death resulted in this kind of accident. Once the short circuit was across the terminals it fused and it was the flash burn that did the damage. The early treatment was a bit difficult because the plastic surgeons did not agree on what should be done, and there were some interesting papers on this subject by Hyslop, who maintained that the surgery should be done within the first few hours, by treating it, removing the debris, and doing grafts. The immediate treatment was definitely for a burns unit and not for the orthodontist at all. He would not, therefore, care to discuss the treatment of pure burns, even intra-oral, because he did not know a lot about them, but the most important thing in the burns unit was sterility.

Mr. B. C. Leighton said that he gathered from the title of the paper that Mr. Glass was inclined to feel

be fitted with non-detachable extension leads (Fogh-Andersen and Sorensen, 1966).

Acknowledgements

I am grateful to Mr. Percy Jayes, the plastic surgeon, and to Mr. Terence Ward, the oral surgeon, for permission to use their material in this publication.

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that the scarring was the cause of the smallness of the dental arches. Mr. Leighton felt that at the age of 1 year the growth of the midline suture would have ceased, and that it was not necessary to postulate a need for any more growth there, but any one of the other factors might have contributed to the smallness. He had noticed also that the inter-molar width between the deciduous molars and the second permanent molars appeared to have increased. Was this in fact so, and to which of the factors would Mr. Glass attribute the most importance?

Mr. Glass, in reply, said that he did not think the midline suture played any important part in growth at all, for in the cleft palate children with no midline suture they grew just as well. As to why the maxilla was so small, if this were due to lack of tissue then why was not the mandible similarly small? One of the worst things was the scarring of the sides of the cheek, which were hard and board-like, and there was no sulcus. He thought that the soft tissue of the cheeks caused most of the contraction, although the skeletal part of the face was not greatly affected.

Mr. B. C. Leighton asked whether the arch was wide or narrow as it was difficult to judge from the slides.

Mr. Glass said that the arch was much wider. The teeth were all leaning in because of the pressure. The mandible was almost fixed, due to the scar tissue, and he thought the contraction of the maxilla was due to the burn across the palate combined with a very large area of scar tissue in the buccinator area.

CLEFT LIP AND PALATE IN ONE OF MONOZYGOTIC TWINS

DONALD I. SMITH, F.D.S., D.Orth. R.C.S.

Consultant Orthodontist, North West Metropolitan Regional Hospital Board

A PAIR of monozygotic, or so-called identical, twins provide us with a controlled experiment. They inherit the same genotype. Differences between the two members of a monozygotic pair are considered to be the product of their prenatal and postnatal environments. Leech (1955) and Benzie (1962) have each reported in detail on a

45 years old and it was her sixth pregnancy. The first pregnancy resulted in a miscarriage at 10 weeks. The subsequent four pregnancies produced single births, and all these children are alive and well. There was no family history of facial clefts. During the course of her final pregnancy the mother reported blood-loss at 7 weeks. At the time of delivery the placenta was described as uniovular with lateral cord insertions.

Table I.—MONOZYGOTIC TWINS WITH CLEFT OF LIP WITH OR WITHOUT PALATE
C L (P) OR ISOLATED CLEFT PALATE C P

AUTHORS	MONOZYGOTIC TWINS			
	C L (P)		C P	
	Concordant	Discordant	Concordant	Discordant
Fogh-Anderson (1942)	7	9	1	8
Walker (1951)				1
Wildervanck (1951)	1			
Douglas (1958)		2		
Metrakos, Metrakos, and Baxter (1958)		2		
Curtis (1959)	2	2		2
Ramsey and Wynn-Williams (1960)		1		
Palmer (1964)	1			
Khoo (1966)		2		
Present case		1		
TOTAL	11	19	1	11

Concordant = both twins affected.

pair of monozygotic twins exhibiting differences of interest to the orthodontist.

In the field of cleft lip and palate investigation there have been reported a number of monozygotic pairs in which one or both had isolated cleft palate or cleft of lip with or without palate. It will be seen from Table I that, among these cases, similar abnormalities are recorded in only 12 out of 42 monozygotic pairs. The corresponding figures for dizygotic twins are given by Metrakos, Metrakos, and Baxter (1958) as 5 concordant pairs out of a total of 79.

CASE REPORT

The female twins who form the subject of this report were born on 20.11.61. Their mother was then

The first-born twin (V.M.) weighed 4 lb. at birth and had a complete cleft of left lip, soft and hard palates. At 1 yr. it was noticed that she had a cardiac murmur, and this was later attributed to a mild pulmonary stenosis.

The twin V.M. had a surgical repair of her lip carried out at 5 mth. by Mr. Ian Muir, of the Department of Plastic Surgery, West Middlesex Hospital. The anterior palate was repaired at 19 mth. and the posterior palate at 23 mth.

The second twin (S.M.) was normal and weighed 5 lb. 13 oz. at birth.

When examined at 3 yr. 2 mth. the twins general appearances, apart from the cleft, were similar. (Fig. 1). There was also similarity of hair and skin colour, iris colour and pattern, finger and nail shape. At this time the affected twin weighed 28 lb. 2 oz. and was 2 ft. 11½ in. tall. The normal twin weighed 28 lb. 7 oz. and her height was 3 ft. 1 in.

Presented at the Country Meeting in Bristol on 14 April, 1967.

The twins proved to be alike in their blood groups. The investigation of parents' and twins' blood groups was carried out at the M.R.C.'s Blood Group Research Unit of the Lister Institute, London. Dr. Ruth Sanger of that Unit very kindly calculated the probability of monozygosity, using the method of Smith and Penrose (1955). It was found that, on the evidence of sex

Tests on their saliva showed that they were both secretors of A antigen.

Occlusion

It will be seen from *Fig. 2* that at 3 yr. 2 mth., the normal twin (S.M.) has a normal occlusion, apart from a slight increase in the incisor overjet. The affected twin (V.M.) has retroclination of



Fig. 1.—The female twins at 3 yr. 2 mth. A, The affected twin (V.M.). B, The normal twin (S.M.).

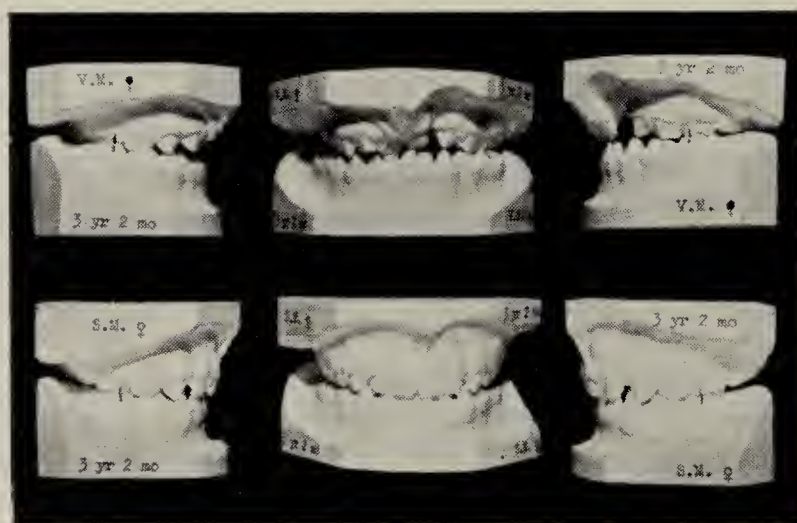


Fig. 2.—Study models of V.M. and S.M. at 3 yr. 2 mth.

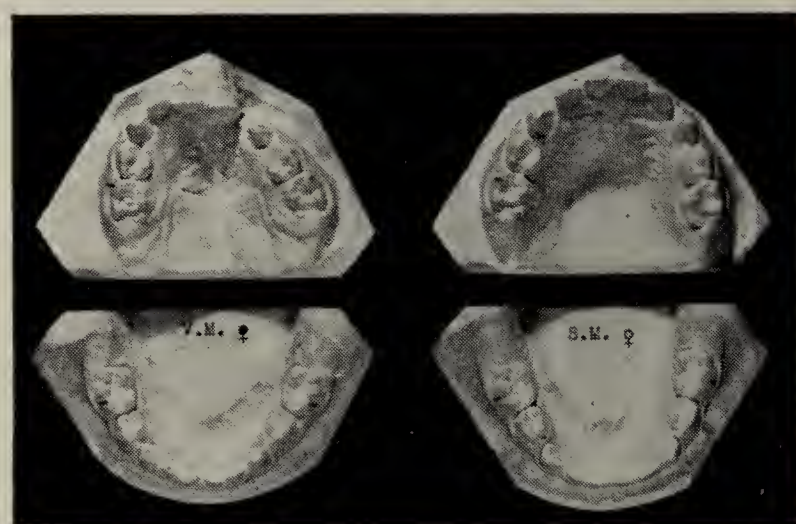


Fig. 3.—Occlusal views of the models at 3 yr. 2 mth.

and blood groups only, the probability of the twins being monozygotic was about 98 per cent.

There are a number of genetically determined variations of the proteins of blood-serum and red cells. I am grateful to Dr. Elizabeth Robson of the Galton Laboratory, University College, London, for analysing blood samples to determine the presence of six of these proteins. The results, when combined with those obtained from the blood groups, make the probability of monozygosity 99.84 per cent.

$\overline{A|A}$, absence of \overline{B} , 'edge-to-edge' relationship of \overline{C} , and the $\overline{E|}$ is in lingual relationship to the lower. *Fig. 3* illustrates the occlusal views of the same models.

Lateral Radiographs

Lateral skull radiographs were taken at 4 yr. 11 mth. and their tracings superimposed on S-N (*Figs. 4, 5*). The affected twin (V.M.) has a shorter S-N distance. She also has upper and

lower dental bases in retroposition, and in profile her mandible is smaller. These differences are to some extent due to their difference in general skeletal development. The affected twin was almost 2 in. shorter at this stage.

imposed by a method based on that of Swoiskin (1957). A base line was constructed by joining the distal points of $\overline{E}|\overline{E}$. A perpendicular to this line was drawn to pass through the point midway between $\overline{A}|\overline{A}$. This provided a 'centre' line which

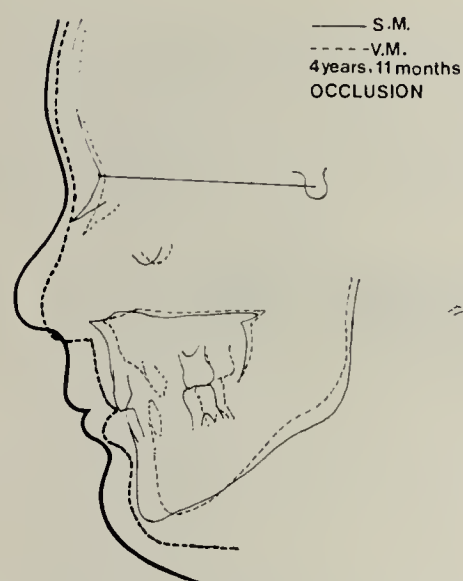


Fig. 4.—Lateral skull radiographs at 4 yr. 11 mth. superimposed on S-N.

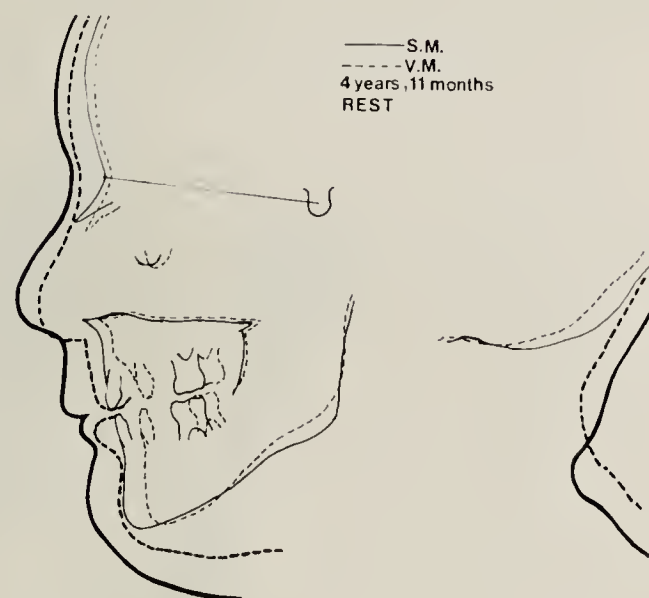


Fig. 5.—Lateral skull radiographs with mandible in the rest position.

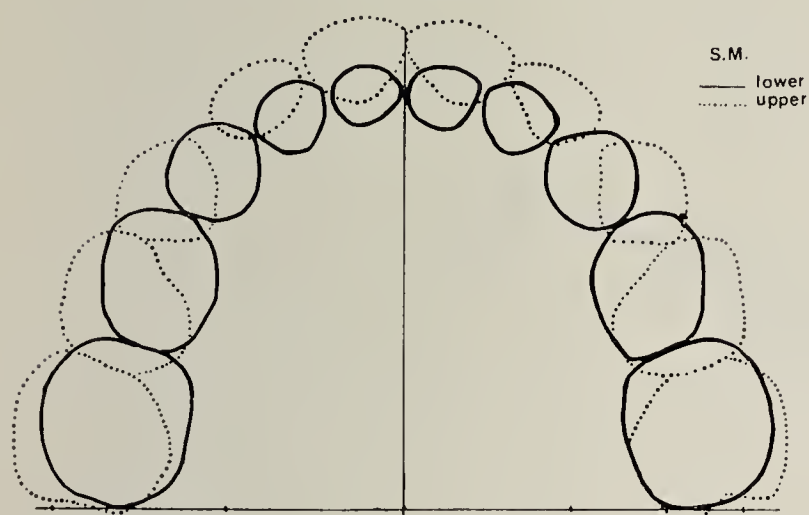


Fig. 6.—Superimposed outlines of upper and lower dental arches of the normal twin (S.M.).

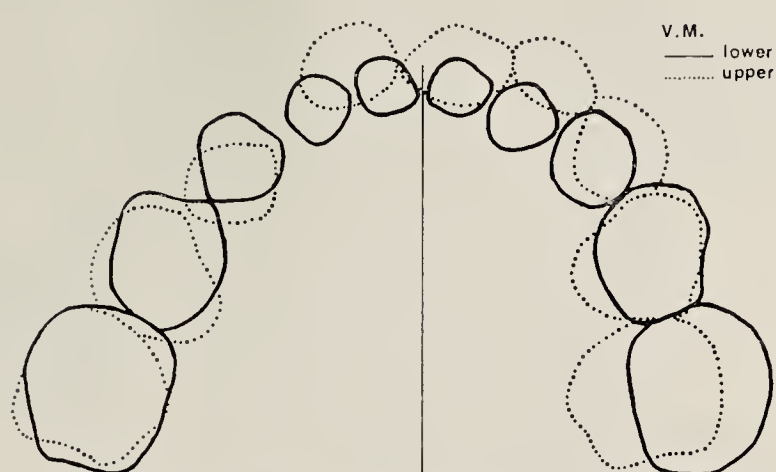


Fig. 7.—Superimposed outlines of upper and lower dental arches of the affected twin (V.M.).

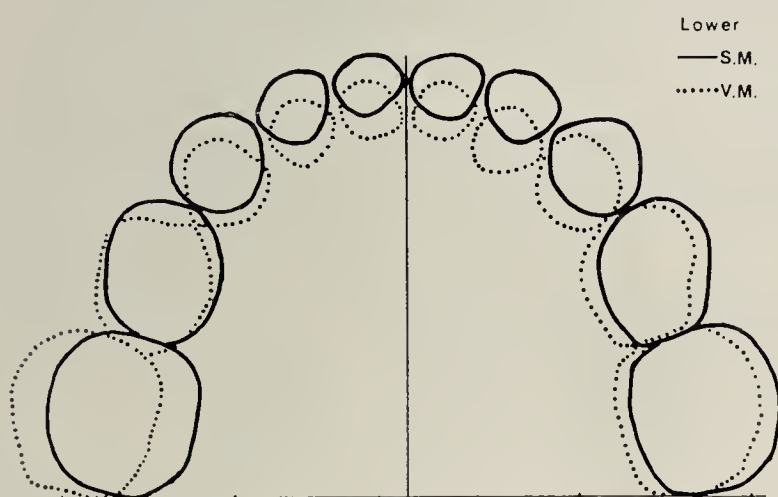


Fig. 8.—Lower arches of V.M. and S.M.

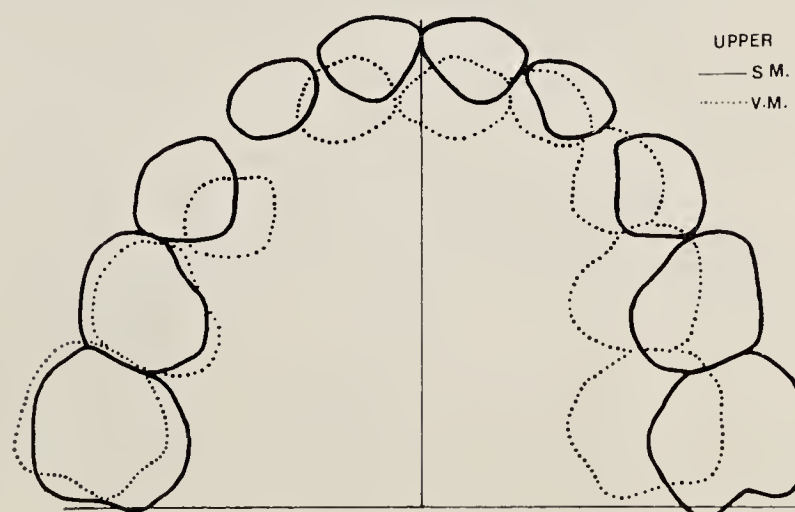


Fig. 9.—Upper arches of V.M. and S.M.

Superimposition of Dental Arches

Using a standardized method, enlargements (approx. $\times 5$) were obtained by placing the models in an epidiascope and tracing the projected outlines. These enlargements were super-

could be transposed to the upper by virtue of the known relationship of upper and lower dental arches. Fig. 6 shows the upper and lower arches of the normal twin (S.M.) and Fig. 7 those of the affected twin (V.M.).

In *Fig. 8* the lines described were used as horizontal and vertical axes to superimpose the lower arch of the affected twin on to that of her normal sister. It shows that the lower arch of V.M. is shorter anteroposteriorly, but almost 2 mm. wider than that of her sister S.M. The

actual measurements at the cervical margins between $\overline{E}E$ were 25.9 mm. for the normal twin, and 27.7 mm. for the cleft twin.

Fig. 9 shows a corresponding superimposition of the two upper arches using the horizontal and vertical axes obtained from their respective lower

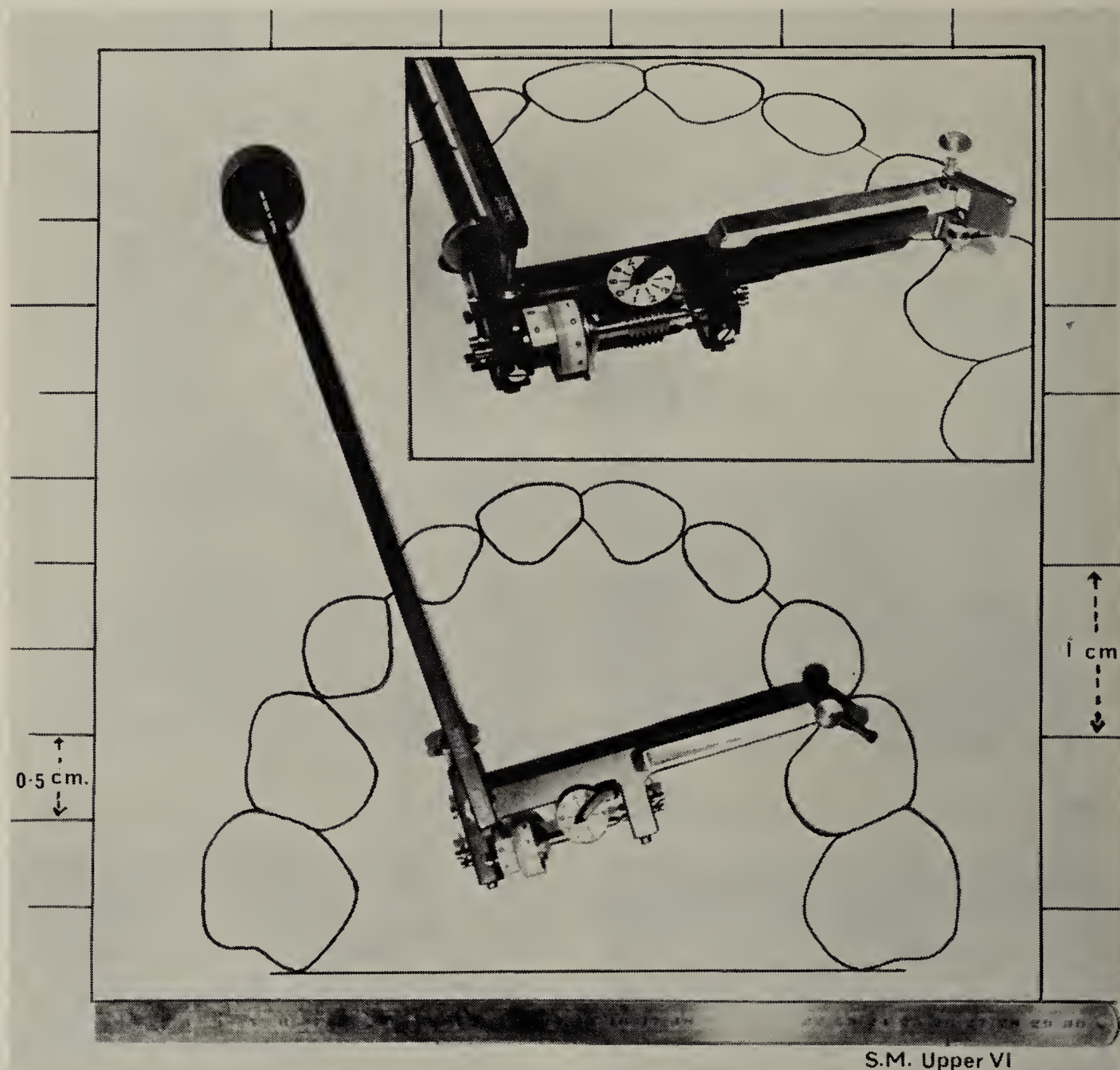


Fig. 10.—Planimeter used to measure the areas enclosed by upper and lower dentitions.

Table II.—AREA OF UPPER EXPRESSED AS A PERCENTAGE OF THE AREA OF THE LOWER. MEASUREMENTS OBTAINED FROM SIX PROJECTIONS OF THE UPPER AND LOWER MODELS OF S.M. AND V.M.

<i>Enlargement</i>	NORMAL TWIN (S.M.)			AFFECTED TWIN (V.M.)		
	<i>Upper</i> (Area in sq. in.)	<i>Lower</i> (Area in sq. in.)	<i>Upper as</i> <i>percentage</i> <i>of Lower</i>	<i>Upper</i> (Area in sq. in.)	<i>Lower</i> (Area in sq. in.)	<i>Upper as</i> <i>percentage</i> <i>of Lower</i>
1	25.12	20.79	121	19.04	19.38	98
2	25.12	20.72	121	19.10	19.49	98
3	25.07	20.72	121	19.00	19.35	98
4	25.41	20.80	122	19.22	19.46	99
5	25.40	20.69	123	19.21	19.46	99
6	25.00	20.64	121	18.91	19.26	98
	Mean		122	Mean		98

arches. The width of the affected twin's upper arch at EIE is 23.8 mm. compared with 26.8 mm. for the normal. It would seem that the narrowness of the cleft upper arch is not due solely to the medial position of the lesser segment.

Areas of the Upper and Lower Arches

A planimeter was used to measure the area of the upper and lower arches. The area measured on the enlargement was that enclosed by the lingual gingival margins and a line joining the

Table III.—UPPER AREA AS A PERCENTAGE OF LOWER AREA FOR A GROUP OF FOURTEEN 3-YEAR-OLDS WITH REPAIRED UNILATERAL CLEFT LIP AND PALATE. ELEVEN NON-CLEFT 3-YEAR-OLDS FOR COMPARISON

Complete Unilateral Cleft Lip + Palate		Non-cleft Controls	
M. R.	109	S. M.	122
D. W.	100	S. M. A.	121
D. G.	114	T. D.	117
P. R.	98	L. T.	130
T. L.	111	L. B.	120
V. M.	98	A. S.	125
S. S.	94	S. S. A.	118
P. C.	126	P. B.	124
B. S.	92	G. R.	117
J. A.	76	A. C.	122
C. P.	122	M. R. A.	121
A. H.	99		
N. F.	106		
D. B.	91		
Mean	101	Mean	122

most distal points of the second deciduous molars. Where neighbouring teeth were not in contact the shortest possible line between them was drawn in order to make the outline a continuous one. *Table II* shows the values obtained from these measurements. The upper of the affected twin (V.M.) had an area of 98 per cent of her lower. The corresponding figure for the normal twin (S.M.) was 122 per cent.

Table III shows the percentage figures obtained from fourteen 3-year-old patients with repaired

unilateral clefts of lip and palate. A control group of eleven non-cleft patients is included for comparison. Although the groups are small the figures suggest that this index may provide a useful measure of the orthodontic aspects of cleft palate patients. It takes into account the possibility of lower arch differences.

SUMMARY

Details were given of a pair of monozygotic twins, one of whom had a cleft of lip and palate. Their lateral skull radiographs appeared to show that the affected twin's upper and lower dental bases were in retroposition. The mandible of the affected twin was smaller in profile. The lower dental arch of the affected twin was wider than that of her sister. An index obtained by expressing the area of the upper as a percentage of that of the lower may provide a useful measure of the orthodontic aspects of cleft palate patients.

Acknowledgements

I would like to express my gratitude to Mr. Ian Muir, Consultant Plastic Surgeon, West Middlesex Hospital, Isleworth, for his help and interest. I am also grateful to the members of the Photographic Department, West Middlesex Hospital, for the illustrations.

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DISCUSSION

Mr. C. D. Parker, referring to the author's comment that the lower arch was wider in the affected twin, asked whether this might have been due to some local tooth movements resulting from the narrowness of the maxilla in the twin with the cleft palate. This could have resulted in a tendency to develop a cusp-to-cusp relation of the buccal teeth on the affected side and, since this was an unstable relation, the result was that the mandibular teeth moved buccally and the

maxillary teeth moved palatally to achieve a better interdigitation.

Mr. D. I. Smith replied that in treating these patients up to now he had thought of the problem in terms of contraction of the upper arch. However, the buccolingual discrepancy might be due in part to the increased width of the lower arch.

Mr. B. C. Leighton drew attention to his own paper on cross bites in non-cleft patients in which he

had found that the lower arch was wider than usual and the upper arch was narrow. This was common.

Dr. J. R. E. Mills said that although the arch was wider it was apparently shorter. He had seen a number of cases of apparently monozygotic twins in whom the occlusion was different, and his impression was that the underlying reason was that in one twin the jaw or dental arch was slightly larger than the other. Usually this did not matter, but occasionally it made a lot of difference. He wondered whether, in this case, putting it rather crudely, the slightly larger twin 'just made it' and avoided the cleft. In that connexion it would be interesting to know whether Mr. Smith had taken radiographs of the developing permanent dentition. Was there any abnormal development of the lateral incisors in the sound twin?

Mr. Smith, in reply, said that he had taken radiographs of the normal twin and these did not disclose any abnormality in the upper lateral incisor regions. He agreed that the growth rate of these twins in the first eight weeks of life might be the deciding factor. There were a number of possibilities, such as the general nutrition of the embryos and the relative growth rates of the parts involved which might tip the scale so that one twin was normal and the other cleft. He quite agreed with Dr. Mills's point.

Mr. D. F. Glass said that surely the interesting thing about this case was that it must be accepted that all children with clefts had a deficiency of mesodermal tissue, therefore there would be a discrepancy in size, apart from the fact that one twin was far better nourished than the other, potentially and in every way. He thought the most important thing about the paper was that the figures gave a very interesting indication as to the degree of tissue deficiency in the unilateral cleft twin compared with the other. The size of the cleft varied considerably but bore no relation to the degree of tissue deficiency, and this case report was the first thing he had seen which might be valuable in assessing how good the results were going to be, for he felt the good results, especially where presurgical dental orthopaedics was employed, were those with little tissue deficiency.

Mr. Smith, in reply, said that as far as general nutrition and development were concerned, it was only the first eight weeks of intra-uterine development that had any bearing on whether or not a cleft was formed. He had no figures of other twins, but it would be possible for the birth weight of the normal twin to be less than that of the affected twin.

Mr. P. R. W. Coyle said that in view of the fact that cross bites might alter the buccolingual relationships of the teeth somewhat and thus the arch area, he wondered whether Mr. Smith thought it might be interesting to measure the apical base area—as with Brodie's method.

Mr. Smith agreed.

Mr. A. G. Huddart said he was currently engaged in the kind of investigation Mr. Glass felt was needed on the changes in the form and dimensions of the maxillary arch in unilateral cleft lip and palate cases following presurgical dental orthopaedic treatment. This included taking area measurements using a planimeter, and, altogether, a hundred measurements were being made, involving sixteen different factors on each model.

The preliminary results showed that, at birth, the overall area of the upper arch in a cleft case was considerably greater than normal, but the actual amount of tissue present was less.

At the age of four to six months, while the area of tissue had increased more in the cleft cases, nevertheless the amount present was still only about 90 per cent of the normal even where presurgical treatment had been undertaken.

In the control cases the figure was about 85 per cent.

At this stage, however, the interpretation of such figures should be approached with extreme circumspection until more detailed information was available.

Regarding identical twins, he had two pairs where one child had a unilateral cleft lip and palate and the other had not. In both pairs the affected child had had presurgical treatment and there seemed to be no real difference between the growth rates of the affected and the normal children in the early months of life.

Mr. D. F. Glass, referring to Dr. Mills's question concerning the lateral incisor, said that he did not think there was any connexion between the absence of a lateral incisor and a cleft, and that it was misleading to suggest there was.

Dr. J. R. E. Mills said that he had not said there was any connexion! What he was implying—and it was very common indeed—was that when there was a cleft of the lip not involving the alveolus it was often found that the lateral incisor had replicated to produce a supplemental lateral.

Mr. D. F. Glass said that it had nothing to do with the cleft.

THE ORTHODONTIC SCENE IN AUSTRALIA AND NEW ZEALAND

JOHN C. RITCHIE, L.D.S. R.C.S. (Eng.)

Westminster Group of Hospitals

IN order to broaden my experience in the orthodontic field and to continue an exchange of ideas with orthodontists in other parts of the world, I decided that a visit to Australia and New Zealand would be very well worthwhile. Discussions of this kind are, of course, reciprocal, because whenever two people meet to talk about a subject of mutual interest, each one learns something from the other, and when you have finished learning, then you are just about ready to retire.

The planning of such a journey takes a very long time, and about a year is required in order to deal with all the correspondence, get in touch with the people you want to see, and write and illustrate some papers which will be of interest to those who entertain you and those who come to listen to what you have to say.

The route taken was to fly round the world from west to east via Rome, Cairo, Bahrain, Colombo, Bangkok, Singapore, Perth, Adelaide, Melbourne, Sydney, Brisbane, Dunedin, Fiji, Hawaii, San Francisco, New York, and London.

Both Australia and New Zealand are thinly populated, except in the capital cities and in these cities two-thirds of the people have their homes. The people of both countries are immediately seen to be very young, they have a pioneering outlook. Often they can be seen to be building their own homes and making their own furniture.

The distances, from a travelling point of view, are vast, but the modern aeroplane will do a journey of 1500 miles from Perth to Adelaide in just over two hours where by car or train it will take up to four days across the desert of Western Australia.

There is a strong likeness to America in many Australian towns, not that there are many American people there at present and one can only imagine that this influence was left over from the wartime years.

There are five dental schools in Australia, one in each of the State capital cities of Perth, Adelaide, Melbourne, Sydney, and Brisbane. Three of the five schools are in new modern buildings, and only in Sydney can you find a dental school, housed in a building some forty years old. The basic teaching of orthodontic

principles seemed to be well taught in these dental schools, but I should like to have seen the students doing far more practical work for themselves in the field of orthodontics. The view was expressed to me on a number of occasions that the Universities, upon granting a degree in Dental Surgery, were urging that there should be a greater amount of academic study and much less technical work done by the students in the Dental Faculty. This attitude is also prevalent in Canada and the United States. Far be it from me to question the outlook and wisdom of the Universities in these countries, but I cannot escape from the conclusion that the practice of good dentistry is a skill which has to be learned over a long period of time and the sooner those fingertips begin their training, then the better practitioners we will have in the world of tomorrow.

I am strongly in favour of 'adaptability tests' for the incoming students to dentistry and by this is meant the carving of a ship or a tooth out of a solid block of wood or soap.

Academic training of a high standard there must be, but let it go hand in hand with manual dexterity, for the betterment of dentistry as a whole. The dental surgeon or the orthodontist will then be able to hold his head high in his own laboratory when he is able to show his technician what he actually wants, and will command nothing but respect if he himself can make the appliance in question.

Much praise must go to the dental school in Sydney for their wonderful idea of the Child Educational Unit which was installed in the waiting area of Children's Dentistry. There were games for children of all ages and instruction by two qualified teachers for the older children. This was the best method of occupying children who were waiting for their treatment which I had seen anywhere in the world.

Private practice in orthodontics in the Australian cities was specialized and highly sophisticated. It was largely American in outlook, and all the orthodontists whom I met had done their postgraduate training either in the United States or in Britain. The demand for orthodontic treatment seemed to be considerable and there

was a very good relationship between the dental surgeons and their colleagues who were in specialized orthodontic practice. The fees obtained were high by British standards, but not so high as those in the New World. The cost of living in Australia might well be 50 per cent higher than in Britain, taking into account the smaller value of the Australian pound, whereas in America the relevant figure might be two and half times greater than in Britain.

It was a great honour and pleasure to be able to talk to that well-known orthodontist Dr. Paul Begg, who dominates the orthodontic sphere in Adelaide. He is respected and admired by all who know him for the wonderful skill which he possesses.

A long day's flying took me from the warm climate of Brisbane, back through Sydney, across the Tasman Sea to the beautiful islands of New Zealand.

There is only one dental school in New Zealand, situated in Dunedin, on the east coast of South Island. This is a university town, and there is a distinctly Scottish flavour about it. Dentistry has been taught here only since 1909 and yet the new and modern dental school is the third of its kind to be built in the city. The Orthodontic Department has as its director Professor Hallam Gresham who, in many respects, sees eye-to-eye with our thoughts here in Britain. The dental students have a broad basis of education in the field of orthodontics which extends for periods throughout the final two years of their clinical study. This method of gaining orthodontic understanding may well have much to commend it.

The private orthodontic practices are mainly concentrated in the large towns. There is a much greater British influence in orthodontics in New Zealand than was to be found in Australia. Once again, in treatment planning, the orthodontist is bound to consider the time and distance involved in bringing his patients from many miles away to his practice, often along indifferent roads.

DISCUSSION

Mr. D. H. Oliver said that he had been very interested in Mr. Ritchie's remarks on the work of the dental nurses in New Zealand and asked whether any such system was in operation in Australia. Was there a need for it there or were the Australians thinking of doing it?

Mr. Ritchie said that he had not actually seen any dental nurses in Australia and had no knowledge whether there were any at all. In the large cities that he visited the dental practitioners seemed to be taking care of this problem very well themselves. But in New Zealand he would have thought it was quite impossible for the practitioners to do all this work.

Each of the islands of New Zealand is 500 miles long.

One of the very striking features of the mouths of the children was that there were very few dental 'cripples'. The New Zealanders are known to have teeth which are not very strong. Their water-supply is mainly soft, and they do not have many fluoridated areas. But they have solved the orthodontist's nightmare of being sent cases in which so much space has been lost by the premature extractions of deciduous teeth. In Britain, we have not yet touched the fringe of this appalling problem. One is forced to the conclusion, that this blessing has been brought about by the Dental Nurses Scheme which has been in operation for some forty years. There is a dental surgery in every school and the pupils regard a visit to the dental nurse in the same way as having any other lesson in the school curriculum. The dental nurse advises expectant and nursing mothers on oral hygiene and basic dietetics. She also deals with the dental problems of the pre-school child. Her work is concerned with conservation treatment and simple extractions for children up to 12 years of age, and she then hands them over to the private practitioners. Dental treatment is free to all children up to the age of 16 years and by that age most of them have learned to look after their mouths, because it has become an integral part of the whole of their school life. There are about 1000 dental nurses and 1000 dental surgeons in New Zealand.

It can be said that the Dental Nurses Scheme is mechanistic in its approach, it may be expensive as a preventive health measure, the wastage may be high, but it has solved a problem and that in Britain we have not done.

The potential in both Australia and New Zealand is vast, largely because of their small populations and wonderful resources. Once Australia has solved its irrigation difficulties, I believe it will become the America of the east.

My grateful thanks are extended to all those who made my tour so enjoyable and the friendly hand which was extended on every occasion.

Mr. A. G. Taylor said that he had been out to New Zealand on two occasions and seen most of the places demonstrated in Mr. Ritchie's beautiful photographs.

According to a letter from a friend in Australia, sixty-five per cent of the New Zealand population were now on fluoridated water-supplies.

Mr. Burton said that as a New Zealander he had been very pleased to see Mr. Ritchie's slides and to hear his talk.

He was all in favour of the system of dental nurses and felt that the orthodontists would really benefit from it.

TONGUE RESTING POSITION

A METHOD FOR ITS MEASUREMENT AND CORRELATION TO SKELETAL AND OCCLUSAL PATTERNS

A. M. COOKSON, B.D.S., F.D.S., D.Orth. R.C.S.

Senior Registrar, Orthodontic Department, Royal Victoria Hospital, Bournemouth

SOME years ago the activities of the tongue were realized to be of importance in the aetiology of malocclusion by Gwynne-Evans (1947), Rix (1946), Ballard (1948), Tulley (1964) and others who paved the way to our better understanding of its significance. Now, clinical examination of tongue activity is as much a part of orthodontic diagnosis as is the assessment of the rest of the soft-tissue morphology.

There is still some controversy over the extent of the tongue's importance, but it is not with its functional role during swallowing and speech that I am here concerned but with its rest position.

A considerable amount of work has been done to try to demonstrate whether there is a reproducible resting position of the tongue. Thompson (1938) used a fine gold chain, one end of which was taped to the subject's chin and the other end swallowed. In this way he hoped to show tongue outline more clearly. Benediktsson (1958) used a suspension of tantalum powder in water, and Garner (1962) painted the tongue with a radio-opaque paste. Using a combination of methods, McKee (1956) also studied tongue resting position and came to the conclusion that there was a reproducible position for each individual, as had the others. Their reasons for investigating tongue position were various but were not, in the main, concerned with any possible correlation with malocclusion.

As far as I am aware, there has been no attempt so far to evolve a method of quantitative assessment of the position of the tongue at rest in relation to the oral cavity. The only possible exception to this is a direct measurement from a single point on the dorsum of the tongue to some skeletal point, as used by Hopkin (1963) and others. Nor has there been, as far as I am aware, any attempt to investigate the relationship between tongue resting position, once measured, and variations in skeletal pattern or occlusion.

It is the purpose of this communication to describe such a method of measuring tongue position, to report some of the pitfalls encountered, and then briefly to discuss the results so far obtained.

If there is such a thing as a reproducible rest position of the tongue, it seems reasonable to assume that this will be adopted when the mandible and the circumoral musculature are at rest. McKee (1956), Garner (1962), and others have investigated and confirmed the existence of such a resting position, but it was Ballard (1959) who suggested the probability of there being two reproducible positions of the tongue. The first would be that which the tongue adopts to contribute to an anterior oral seal when the mandible is at rest. The second would be the truly or physiologically relaxed position of the tongue, when the afferent stimuli which contributed to establishing habitual position have been removed. In other words, if the lips are parted and, in some cases the mandible is slightly opened from rest, the tongue will drop back in the mouth to a more distal position with the dorsum well rounded. Both these positions are reproducible for any one individual.

However, it is the former or what might be called the habitual position that the tongue will occupy for the majority of the time. This is, the position of the tongue with the mandible at rest, and is therefore the position most frequently seen on X-rays taken with the mandible at rest.

An investigation of this sort must be based on a combination of clinical and cephalometric observation. Clearly the tongue cannot be seen in the ordinary way at rest, and so using clinical assessment of the physiological rest position of the mandible, X-rays have to be used to record tongue position.

Ideally, these would be three-dimensional, but although the outline of the tongue can be seen quite clearly on a lateral skull X-ray, it cannot be seen anything like so clearly on an antero-posterior view. Initially, I tried painting on radio-opaque pastes of varying viscosity to show its outline more clearly, but by the time the patient had been fully relaxed, the paste had either spread all over the mouth, obscuring everything on X-ray; or else, if it was thicker and more glutinous, it undoubtedly interfered with the establishing of any true

rest position—a finding confirmed by Berry and Wilkie (1961) in their work on tongue position in relation to denture stability.

So I had to be content with a two-dimensional assessment. However, this is all the information which has so far been available to other observers, and so it was decided to continue with the attempt to verify some of the more commonly held beliefs regarding tongue resting position.

Material and Method

A series of 150 patients referred to the Orthodontic Department of the Royal Dental Hospital had lateral skull X-rays taken with the mandible

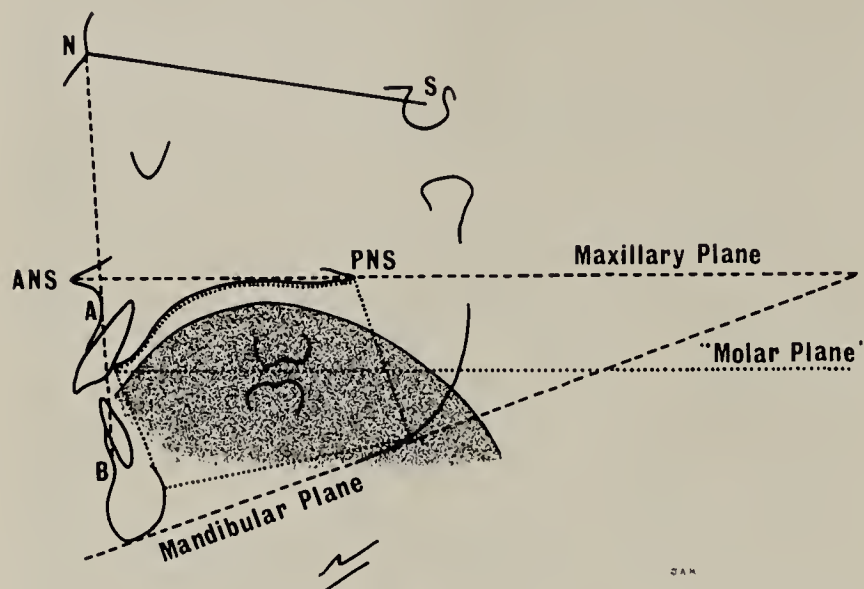


Fig. 1

in its rest position. Some considerable time was spent in relaxing and reassuring the patient during this procedure, and two X-rays were taken at intervals of a few minutes. A third was taken with teeth in occlusion for routine diagnostic tracing. Ideally one would have taken more X-rays, but radiation hazards rendered this undesirable. If the X-rays taken at rest could not be superimposed exactly, they were discarded, and in this way 130 patients were left. *Table I* shows their skeletal patterns assessed by the conversion of incisor angulation as described by Ballard (1948). Occlusal classification is shown in *Table II*.

Stepovich (1965) found it impossible to reproduce hyoid position, but, in the subjects under investigation here, there were only a few in which any variation in hyoid position was noted. These were discarded anyway because of some variation in tongue position on the two X-rays taken. The usual checks were made on the accuracy of the measurements, a sample number of the cases being retraced and re-measured to check for error. The original X-rays could not be repeated as the patients had subsequently received orthodontic treatment.

All clinical assessments were made by the same person, and all X-rays taken by the same radiographer with myself or Mr. MacDonald present.

Routine tracings including tongue outline were done for cases accepted. A figure was constructed (*Fig. 1*) which could be said to represent the area of the oral cavity. A line was drawn from posterior nasal spine to gonion; from gonion to the point of maximum curvature of the lingual surface of the symphysis (this point was used because the genial tubercles are rarely visible on a lateral skull X-ray); from this point to the palatal alveolar margin of the upper central incisor, and then following the contour of the hard palate.

Another line was drawn parallel to the maxillary plane and passing through the mid-point of the intercusp distance of the first permanent molars. This is in no sense an occlusal plane. For want of a better name I have called it the 'molar plane'.

The following areas were measured using a planimeter: the area of the total figure, the area above the molar plane, and the area occupied by the tongue. The tongue area was then expressed as a percentage of the total area, and tongue area above the molar plane as a percentage of the corresponding oral cavity area.

Although three-dimensional measurements could not be made, it is possible to check whether

Table I.—SKELETAL PATTERNS OF THE CASES INVESTIGATED

	Cases
Class I	34
Class II	69
Class III	27

Table II.—OCCLUSAL PATTERN OF THE GROUP INVESTIGATED

	Cases
Occlusal Class I	43
Occlusal Class II, div. 1	48
Occlusal Class II, div. 2	12
Occlusal Class II, indefinite	9
Occlusal Class III	18

there is any correlation between high or low tongue position (represented as a high or low percentage) and the incidence of lateral variations such as unilateral or bilateral cross-bites.

RESULTS

Before conducting a full analysis of the findings it was first necessary to ascertain whether there were significant differences in tongue and oral cavity sizes. It was not considered wise to break down the cases into too many small groups. Results were examined first of all for age and sex difference.

Cases above 12 years of age showed significantly larger dimensions of tongue and oral cavity than the younger cases, as would be expected. However, when tongue area as a proportion of

oral cavity area was examined, no significant differences were found (*Table III*).

Next, males and females were examined, the groups being balanced for age. Elsasser and Wylie (1948) have found that facial dimensions in males are larger than those in females and this was confirmed in the present investigation—the

In none of these cases was any correlation found. There were no significant differences between any of the groups (*Table IV*).

High and low maxillary-mandibular-plane angle cases were compared, and again no significant differences for any of the groups were found except when total tongue area was expressed as a

Table III.—TONGUE AREA IN RELATION TO AGE AND SEX

	N	ORAL CAVITY AREA (sq. cm.) Mean (\pm S.D.)	T	TONGUE AREA (sq. cm.) Mean (\pm S.D.)	T	TONGUE AREA Per cent Mean (\pm S.D.)	T
Age							
Above 12 yr.	52	26.66 (3.41)	4.25	21.23 (3.16)	4.47	79.69 (7.17)	1.21
Below 12 yr.	52	24.11 (2.68)	**	18.83 (2.23)	**	78.21 (5.13)	
Sex							
Male	40	25.20 (3.23)	1.87	19.03 (2.48)	0.78	75.64 (5.11)	4.89
Female	40	23.98 (2.62)		19.46 (2.52)		81.10 (4.87)	**

**=Significant at 1 per cent level.

Table IV.—TONGUE AREA IN RELATION TO SKELETAL PATTERN

	N	ORAL CAVITY AREA (sq. cm.) Mean (\pm S.D.)	T	TONGUE AREA (sq. cm.) Mean (\pm S.D.)	T	TONGUE AREA Per cent Mean (\pm S.D.)	T
<i>SNA-SNB Difference</i>							
Less than 4.5°	52	24.74 (3.60)	0.07	19.58 (3.02)	0.33	79.18 (5.23)	0.80
More than 4.5°	52	24.69 (3.82)		19.36 (3.78)		78.27 (6.33)	
<i>Skeletal Class</i>							
Class II	27	24.16 (3.26)	1.21	19.96 (2.83)	1.01	78.51 (6.08)	0.15
Class III	27	25.38 (4.08)		18.87 (3.73)		78.23 (7.20)	
<i>MML</i>							
High (30° and above)	63	24.73 (3.40)	0.65	19.14 (2.76)	1.90	77.56 (6.41)	2.38
Low (29° and below)	63	25.12 (3.29)		20.14 (3.14)		80.13 (5.68)	*

*=Significant at 5 per cent level.

oral cavity areas in males being greater. It was, however, very surprising to find that in the female group tongue area was slightly greater, and that, when this area was expressed as a percentage of oral cavity area, the values for females were significantly greater than those for males—a finding for which no satisfactory explanation can be offered (*Table III*).

The relationship of skeletal pattern with tongue area, with oral cavity area, and with tongue area expressed as a percentage of oral cavity area was then investigated. Skeletal pattern was assessed on the basis of SNA/SNB differences and on the basis of conversion of incisor angles as already described.

percentage of total oral cavity area. In this case there was a difference, but at the 5 per cent level only (*Table IV*).

Similarly, the cases were divided into the larger occlusal groups, balanced for age and sex, and tested for significant differences. The same comparison was made for those who were and those who were not thumb suckers, and lastly for those patients who had and those who did not have a cross-bite in the buccal occlusion.

In none of these cases was any correlation shown between tongue position as expressed by the method of percentages. There was a correlation between tongue and oral cavity size and the incidence of thumb sucking (*Table V*). No

explanation can be offered for the finding. No correlation was found between tongue resting position measured as a percentage and any of the groups investigated with the exception of high compared with low maxillary-mandibular-plane

particular findings. However, there is an equal lack of correlation in the other groups.

At the present moment, there seem to be two opposing schools of thought on the relative importance of the tongue and lips in the establish-

Table V.—TONGUE AREA IN RELATION TO OCCLUSION AND INCIDENCE OF THUMB SUCKING

	N	ORAL CAVITY AREA (sq. cm.) Mean (\pm S.D.)	T	TONGUE AREA (sq. cm.) Mean (\pm S.D.)	T	TONGUE AREA Per cent Mean (\pm S.D.)	T
<i>Occlusion</i>							
Class II, div. 1	23	25.84 (4.46)	0.13	20.39 (4.78)	0.37	78.58 (7.28)	0.51
Class III	23	25.67 (4.28)		19.91 (3.83)		77.52 (6.90)	
<i>Occlusion</i>							
Class I	12	25.08 (2.39)	0.62	19.91 (1.94)	0.12	79.53 (5.40)	0.58
Class II, div. 2	12	24.37 (3.23)		19.77 (3.48)		80.89 (6.06)	
<i>Cross-bite</i>							
Present	14	24.53 (3.47)	1.36	19.32 (3.26)	1.13	78.66 (6.28)	0.11
Absent	14	26.41 (3.81)		20.59 (2.67)		78.38 (7.05)	
<i>Habits</i>							
Thumb suckers	28	25.41 (2.90)	2.61	20.04 (2.86)	2.68	78.78 (5.73)	0.81
Non Thumb suckers	28	23.35 (3.01)	*	18.10 (2.56)	**	77.56 (5.50)	

*=Significant at 5 per cent level.

**=Significant at 1 per cent level.

angle cases. This was only at a low level of significance.

DISCUSSION

This general lack of correlation was unexpected and it seemed desirable to consider possible sources of error.

All measurements were cross-checked and a sample number of cases re-traced. These showed no significant error so the only likely source seemed to be the original radiographs. If these were not in the rest position, a lack of correlation might be expected.

On close inspection it was seen that in a few cases the tongue was not right forward in contact with the lower lip, but equally certainly it was not fully relaxed back into the oral cavity. All cases were, as far as could possibly be ascertained, X-rayed with the mandible in a true rest position and, what is more important, in a position which was exactly duplicated on two X-rays taken at an interval of several minutes. It is a matter of some conjecture whether this was the habitual rest position of the tongue in those cases or not.

The lack of correlation of some of the occlusal groups (*Table IV*) could with every justification be attributed to the small numbers of cases and therefore no great significance is attached to these

ment of lower incisor position. If there is no significant correlation between any particular skeletal pattern and tongue position at rest, a more likely correlation might be that between tongue size and size of oral cavity. Furthermore, if one momentarily accepts the postulate of a habitual position of the tongue, then, accepting that tongue size and oral cavity size will be under separate genetic control, it is surely not unexpected that there is no direct relationship between tongue resting position and skeletal pattern as such. In other words, the lack of correlation of these findings would seem, if anything, to confirm that tongue position is dictated by environment and the afferent stimuli from that environment.

One other point may be worth making. In Class III cases it is commonly stated that a narrow maxillary arch is due to a low tongue position, and that a unilateral or bilateral cross-bite has resulted. This belief would seem to be discounted in the light of these findings, firstly, because no correlation was found between tongue resting position and either skeletal or occlusal Class III cases and, secondly, because of lack of correlation with the incidence of cross-bite in these cases. It must, however, in fairness, be emphasized that the numbers in this latter group were fairly small.

In conclusion, it must be stressed that the main reason for producing this paper was to describe

a method for the measurement of tongue resting position as seen on lateral skull X-rays. The major difficulty is that although one can measure the amount of tongue seen on X-ray within the confines of the oral cavity, one cannot measure tongue size extending, as it does, back into the oro-pharynx, down to the hyoid bone, and laterally to an, as yet, unmeasurable extent.

Therefore, it is with some caution that I have produced the results so far achieved, but I feel that if they only contribute to the general discussion on the significance of the role of the tongue in its resting position, they will have served their purpose.

Acknowledgements

My thanks are due to Professor Walther for his help and encouragement throughout this project, to Dr. Blackman, and Miss Semple, of the Department of Radiography at the Royal Dental Hospital, and other members of the Staff of the Orthodontic Department there—in particular Mr. MacDonald. I would also like to thank Mr. Houston for his very considerable help with

the statistics involved, and Professor Ballard for his invaluable criticisms and comments.

Lastly, I would like to thank the President, Mr. J. D. Hooper for his help and consideration throughout the period of time involved in preparing this paper.

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DISCUSSION

Professor W. J. Tulley drew Mr. Cookson's attention to a doctorate thesis in New Zealand testing Professor Ballard's relaxed position as against the habitual postural condition.

Professor Tulley could not be convinced that this was a physiological position of the tongue. To let the mandible hang down and to let the tongue fold back—the way Professor Ballard described as the basic relaxed position of the tongue—did not sound terribly physiological.

The author had examined the position of the tongue and the lack of correlation between the 'relaxed' position and the 'habitual postural' position was not surprising. Professor Tulley felt that the tongue position had been rather overdone and that it was time to go back to skeletal patterns.

Mr. A. G. Taylor said that he did not care for this word 'relaxed'. It had been heard several times here. It was a word that was so fashionable as to have become a piece of jargon in general use, and there was not a good definition of what 'relaxed' meant in relation to orthodontics. He could understand the patient being relaxed when an electro-encephalogram was done, for one would remove as many stimuli as possible, but how could just one organ become relaxed?

Mr. Cookson said that all he could do was to repeat what Professor Ballard himself had said. He had described two positions, a relaxed and a habitual resting position. Before the postulate of two positions had been put forward, he had only considered the possibility of there being one, and, if it existed, that it would correspond with the habitual position. The relaxed position as Mr. Taylor suggested would seem to require that, ideally, the organ be entirely isolated from its environment.

Mr. D. J. Timms suggested that Mr. Cookson had fallen into a trap which catches many orthodontists.

When they say 'rest position', they mean 'resting from dental activity', but people are still living and breathing. Respiration has the prior biological claim, not mastication, for most of the time. It is therefore necessary to correlate tongue position with airway patency and consider pharyngeal morphology, size of lymphoid tissue, etc. It has been shown that one drops the mandible with large tonsils and raises it after removal.

It would appear that tongue position is influenced by environmental factors—a point noted by Mr. Cookson—and whilst these factors have not yet been clearly defined, respiration must be high on the list.

Mr. Cookson said that this paper was concerned with the rest position of the tongue and any discussion concerning the factors governing the resting position of the mandible could go on for a long time. He accepted Mr. Timms' comments, but did not agree with his argument. It was not, however, possible to reply in a few words.

Mr. T. Jason Wood said that he could give some estimation of the difference between resting and relaxing given to him by an international rifle shot. The great thing with rifle shooting was to be relaxed. To illustrate this the expert had told him to sit down on a chair and rest with arms hanging down. He was then told to see if he could push his arms further down. The expert then said, 'The amount by which you have pushed your arms down is a measure of the difference between resting and relaxing.'

Mr. Cookson said that Professor Ballard cited the work of Joseph who showed, using the electromyograph, that in the resting posture there was some electrical activity, whereas in the relaxed posture none was detectable.

Professor W. J. Tulley said that Dr. Joseph, who was quoted by Professor Ballard, had not worked on the mandibular elevators at all but on the limbs.

Working on the mandible he had not himself been able to get a silent electromyograph. It really came back to what Mr. Timms said, that an airway had to be maintained, so that there could not ever really be a completely relaxed position of the mandible. It was a different area for consideration altogether compared with the limbs, which could be really relaxed when people were lying down.

Mr. D. G. Huggins said that he was very interested in Mr. Cookson's project and wondered whether he

might have approached the matter slightly differently, trying to assess the volume of the tongue and of the oral cavity, using ultrasonic technique.

Mr. Cookson said that the safest answer was 'no'. He knew nothing about ultrasonic techniques. Various techniques had been considered for assessing oral cavity volume, but as they had involved the introduction of some object into the mouth, they automatically interfered with the resting position of the tongue.

CLEFT PALATE IN THE DOG

J. D. ATHERTON, B.D.S., F.D.S., D.D.O.

The University of Liverpool

IN this paper a group of 24 newborn dogs with a cleft of the secondary palate is examined. Particular attention is paid to the palatal shelves and the relationship of the tongue to these shelves. The dog demonstrates the variability of tongue position found in humans with similar clefts and has the advantage to the investigator of being available for histological examination.

It is well known that the tongue and palatal shelves are intimately related in cleft palate patients. References may be found in standard textbooks such as that by Veau (1931) and in many papers, for example, Slaughter and Pruzansky (1956), Burston (1958), and others, to the role of the tongue in determining the morphology of the cleft upper jaw.

Usually in cleft palate babies the tongue is found in the mouth, but occasionally (Pruzansky and Richmond, 1954) may be found lying between the palatal shelves and in the nose. This latter condition is associated with a cleft of the secondary palate only and usually a small lower jaw. Patients presenting with these features (the Pierre Robin syndrome) may have feeding and breathing problems of considerable magnitude.

The varying inclination of the palatal shelves in man has been examined by Subtelny (1955) using cephalometric laminography. He observes that the palatal shelves of cleft patients demonstrate a greater variability in inclination than in the control patients, and that there is a more frequent occurrence of the palatal shelves being inclined toward the floor of the mouth.

Latham (1966) describes the anatomy of a human foetus, aged 17 weeks, with a cleft palate associated with the Pierre Robin syndrome.

MATERIAL AND METHODS

The cleft-palate dogs used in this study were referred to the author by veterinarians and dog breeders shortly after birth. The animals were received dead, having been killed by the veterinarian or having died because of the failure to suckle, which usually accompanies this defect. The 24 specimens received to date were fixed in buffered formol-saline.

The heads of the specimens were then either macerated in order to display the structure of the bones or prepared histologically for more

detailed anatomical study. The maceration technique used was that described by the author (Atherton, Burston, and Clore, 1965) modified by the use of Ward's Bioplast* instead of Bakelite resin. The specimens for histological preparation were either embedded and sectioned in celloidin which gives an excellent picture of the relation of the parts, but because of the thickness of the section (22 μ) lacks cellular detail, or double embedded in wax using a modified Peterfi's technique which gives less perfect large sections but good cellular detail.

OBSERVATIONS

1. Gross Appearance

The external appearance of the majority of the specimens received was quite normal. Six specimens differed in that there was an obviously small lower jaw (*Figs. 1, 2*). These specimens were siblings and had associated malformations of the limbs and paws (*Fig. 3*). Two other specimens, again siblings, presented a mild distortion in shape of the fore and hind limbs.

All the specimens had a complete cleft of the secondary palate extending posteriorly from the region of the incisive foramen. No incomplete clefts were received.

The position of the tongue in relation to the cleft varied. In the majority of specimens the tongue lay in the floor of the mouth and ventral to the palatal shelves. In 9 specimens the tongue lay dorsal to the palatal shelf and in the nose on one or both sides.

When the tongue lay in the floor of the mouth, with two exceptions, to be mentioned later, the palatal shelves extended horizontally above it. When the tongue lay in the nose the palatal shelf was displaced ventrally (*Fig. 2*).

2. Gross Observations on the Bones of the Palate

The bones which showed defective development or displacement were the maxilla, palatine, pterygoid, and vomer bones. No abnormalities were found in the other bones of the skull.

The maxilla and palatine bones showed a reduction in the width of the horizontal process

*Obtainable from Ward's, P.O. Box 1712, Rochester, New York, U.S.A.

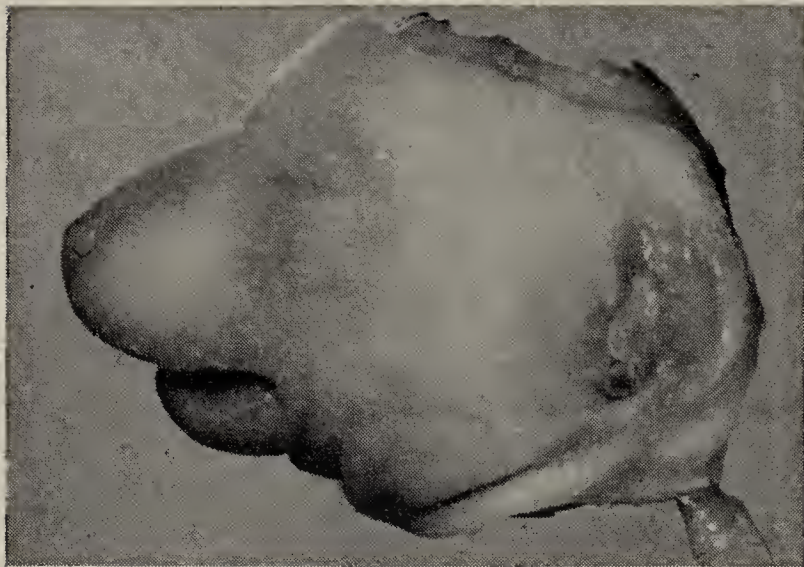


Fig. 1.—The lateral view of the premature poodle, one of a litter of six, all with similar features.

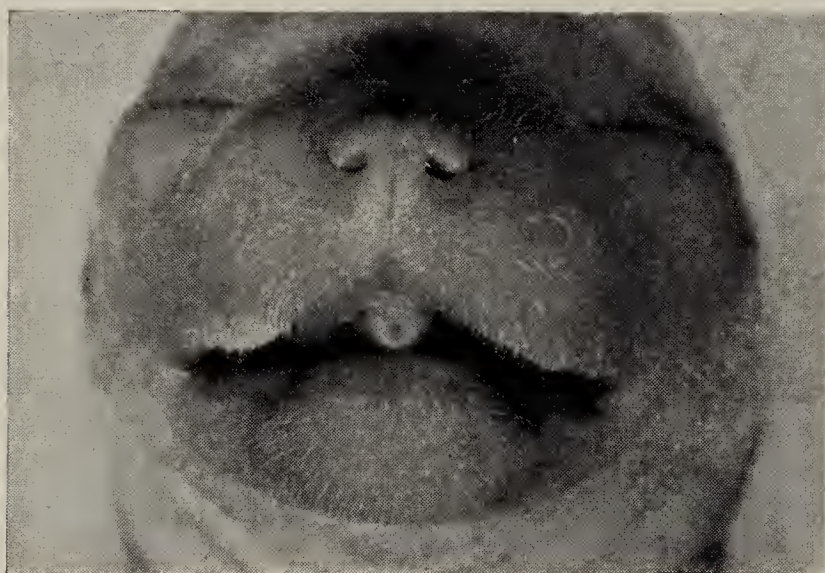


Fig. 2.—The frontal view of the same specimen as in *Fig. 1*. The tongue lies between the palatal shelves and in the nose.



Fig. 3.—The deformities of the limbs and paws seen in this specimen are typical of the whole litter of premature poodles.



Fig. 4.—The palatal aspect of the skull of a control beagle prepared by maceration, alizarin staining, and mounting in plastic.

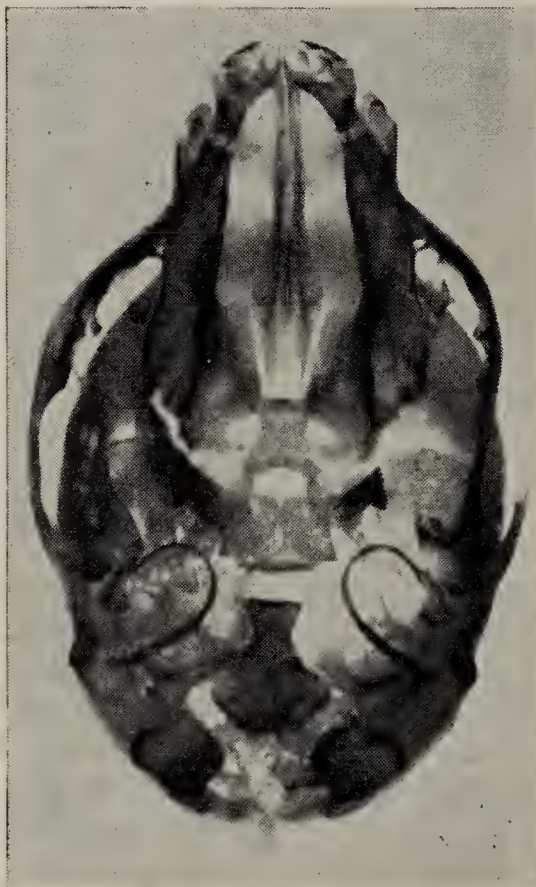


Fig. 5.—The palatal aspect of the skull of a premature poodle. The tongue lay between the shelves and in the nose.

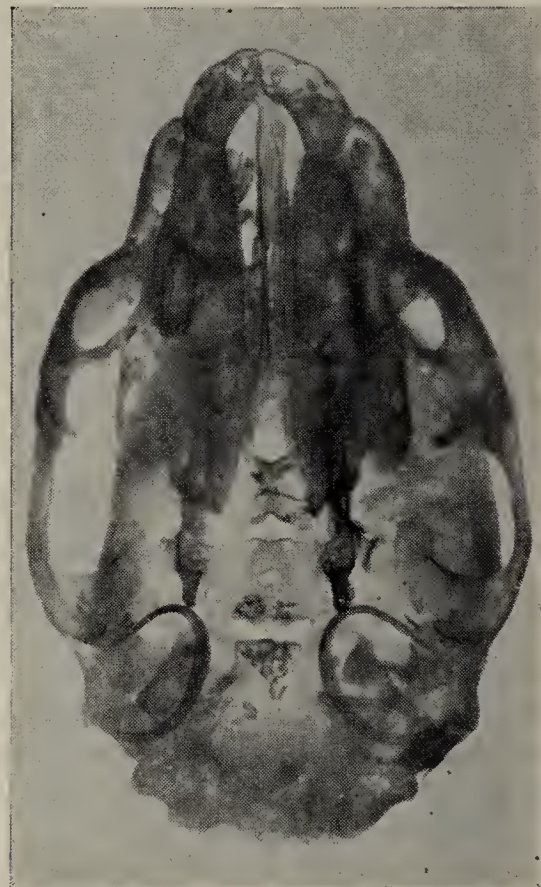


Fig. 6.—The palatal aspect of the skull of a Norwegian elk-hound. The tongue of this specimen lay in the floor of the mouth.

(Figs. 4, 5, and 6). When the tongue lay in the nose, the ventral or downward displacement of the palatal shelves led to a wider cleft between the shelves than when the shelves were horizontally placed (Figs. 5, 6). There was also some lateral displacement of the body of the palatine bone in the region of the soft palate.

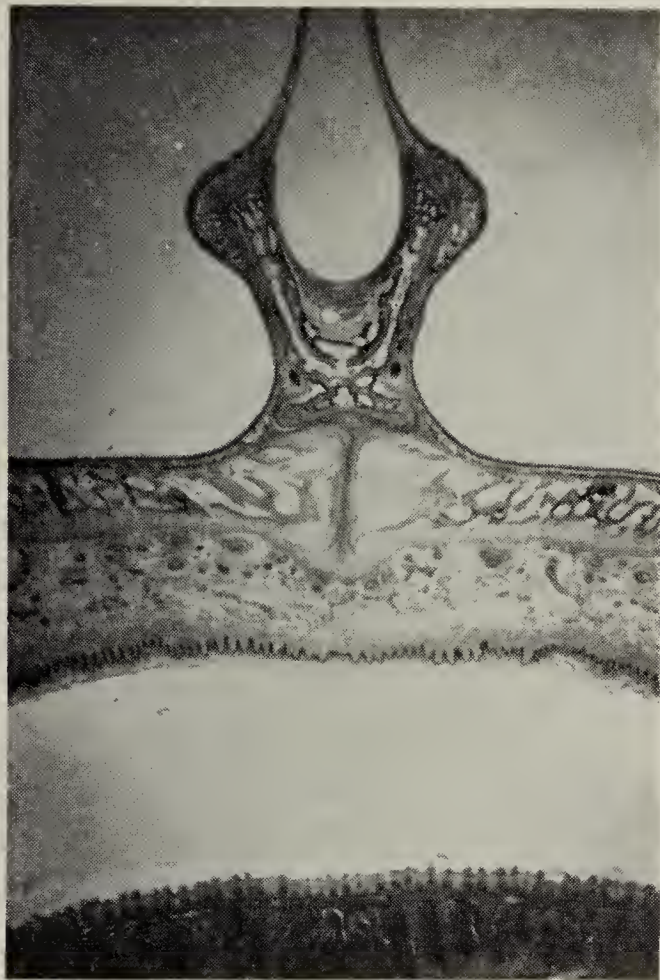


Fig. 7.—A section taken through the anterior part of the palate of a control beagle. (Celloidin embedded, cut at 24μ Masson stain.)

The pterygoid hamulus, in non-cleft specimens inclined medially and slightly ventrally. In the cleft specimens the hamulus was displaced laterally and pointed directly posteriorly.

The vomer bone is best seen in cross-section and will be mentioned in the following section (3).

3. Histological Observations

The non-cleft newborn dog showed evidence of active growth at the margins of the palatal shelves. The appearance of the suture region in the anterior part of the secondary palate is shown in Fig. 7. The shelves met end on and as they approached each other, thickened until at the junction between the two bones there was a wide flat surface. The inferior surface of each bony shelf was covered with a layer of cells described by Pritchard, Scott, and Girgis (1956) as the 'cambrial' layer of the periosteum. The periosteum extended from the inferior surface of the shelf on to the median border where it was separated by a few small capillaries from that of the opposite side. New bone was deposited by

the inner osteoblastic cells of the cambrial layer on the inferior surface and more actively on the flat median border of each shelf where a thick layer of newly deposited pale-staining woven bone was laid down at right-angles to the suture surface. The upper surfaces of each shelf were undergoing resorption. Multinucleated giant



Fig. 8.—The palatal shelf of a specimen in which the tongue lay in the floor of the mouth. Deposition of bone is occurring at the margin of the bone and on the inferior surface and resorption at the superior surface. (Sectioned in wax at 10μ Masson stain.)

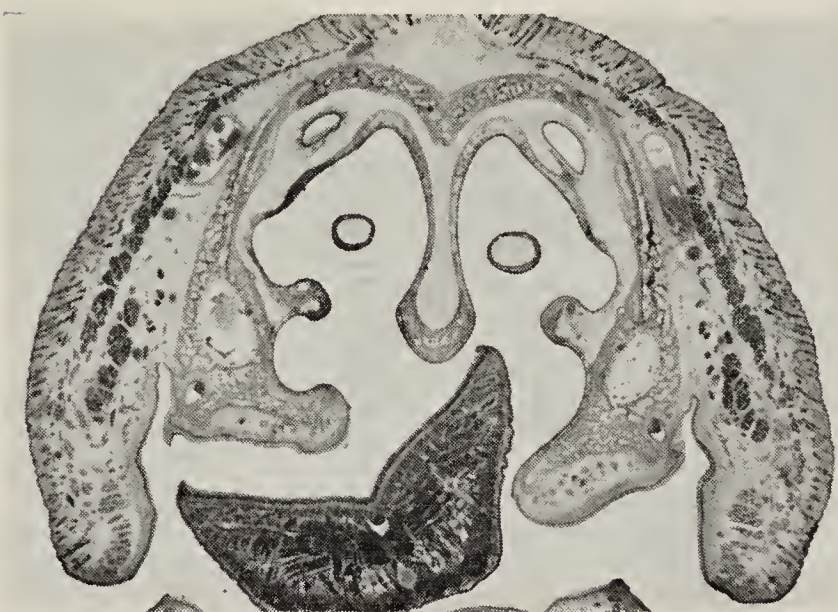


Fig. 9.—A section taken through a premature poodle head in which the tongue lay in the nose on one side and in the mouth on the other. The appearance of the shelf on the right of the photograph is typical of those specimens in which the tongue lies in the nose. The shelf on the left is shown in more detail in Fig. 11. (This and the remaining figures are celloidin embedded and stained with Masson.)

cells were particularly frequent on the upper surface in the region adjacent to the thick median border where it was apparent that as the shelf grew it must be reducing in thickness.

The vomer bone in this region lay above the suture between the two maxillary bones with its cambrial layer clearly separated from them.

The surfaces of the vomer were in general undergoing deposition. The greatest osteoblastic activity was seen on the superolateral surface on each side and on the inferior border. The inner surface which faces the nasal septum was less active.

The cleft specimens also showed growth at the shelf margins, but there were variations which may be of significance. The appearance of a horizontally disposed shelf (with the tongue in

was taking place on the superior surface and deposition on the inferior surface, as with the non-cleft specimen. When the shelf lay beside the tongue (with the tongue in the nose) the shelf presented a similar histological appearance (*Fig. 9*) to the above, apart from the direction of growth which was downwards and inwards.

Certain variations were seen to the above description. One specimen showed a thick layer of cartilage at each shelf margin in the anterior

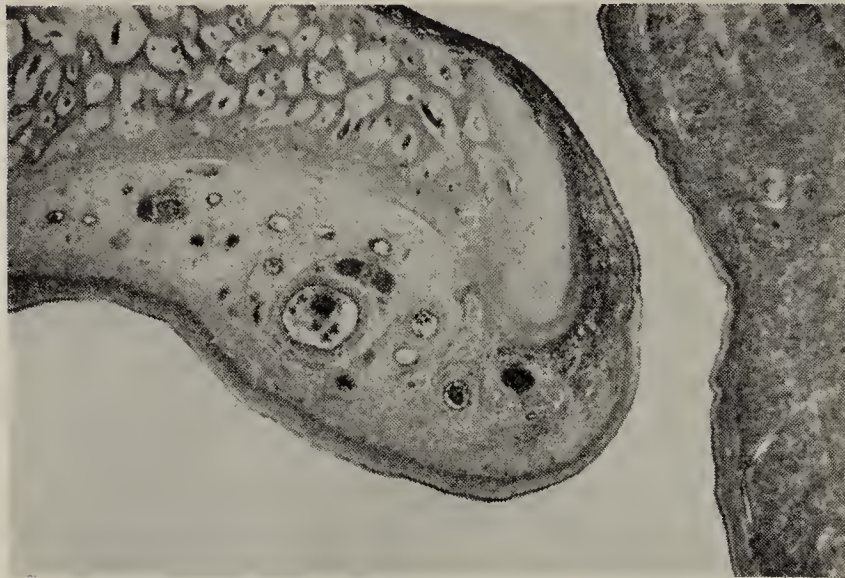


Fig. 10.—The shelf margin of another of the premature poodle litter showing a cartilaginous mass at the margin of the shelf.



Fig. 11.—Detail of the shelf shown in *Fig. 9*. The area of the resorption on the medial aspect of the inferior surface (marked on the photograph by a bracket) and the upward inclination of the growing margin of the horizontal process of the maxilla was only seen in this specimen.

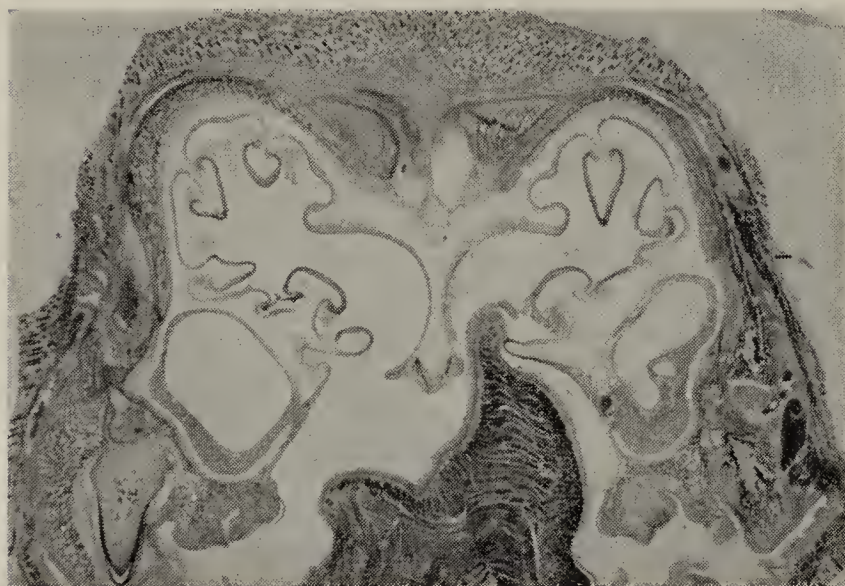


Fig. 12.—A section taken between the premolar and molar regions of a dog presenting with an incomplete bilateral cleft of the primary and a complete cleft of the secondary palate. The palatal shelf on the left side of the photograph is only half the width of the right shelf. The vomer is deformed by the tongue. There is a wide defect between the frontal bones which extends forwards to involve the nasal bones.

the floor of the mouth) is shown in *Fig. 8*. The general direction of growth was inwards. The growing shelf margin lacked the thickening which was seen in the non-cleft specimen towards the midline. Nevertheless, rapid growth was indicated by the thick cambial layer and numerous osteoblasts against the bone surface. Resorption

part (*Fig. 10*). This specimen was a premature poodle (*Figs. 1, 2*) and sibling to the specimens shown in *Figs. 5, 9*. It was considered that the cartilage was indicative of active growth since it is occasionally seen in the same region in newborn normal dogs.

Another specimen from the same litter showed an interesting variation. This was a distinct upward turn of the shelf margin (*Figs. 9, 11*). Deposition of bone was occurring at the margin of the shelf and along the lateral two-thirds of the inferior surface. Resorption was occurring along the lateral two-thirds of the superior surface and along the medial third of the inferior surface as far as the tip-up of the margin. No other specimen showed resorption at this latter site. It was considered that the pattern of resorption and deposition seen here indicates a change in direction of growth from downwards to horizontal.

A specimen with an incomplete cleft of the primary palate and a complete cleft of the secondary has been included in this study. The specimen showed a difference in the development between the shelves on each side (*Fig. 12*). On the side on which the shelf is growing well the tongue lay in the nose. On the other side the shelf showed a reduction in development, when compared with the opposite side. The superior

surface of the tongue was directed against the margin of this shelf. Shrinkage due to histological processing has caused the tongue to come away from the shelf. In life the tongue would be applied directly on the shelf margin. More posteriorly the tongue passes into the nose and the shelves assume a similar position and size on each side.

The vomer bone in all specimens (e.g., *Fig. 9*) was reduced in size in its inferior aspect and here

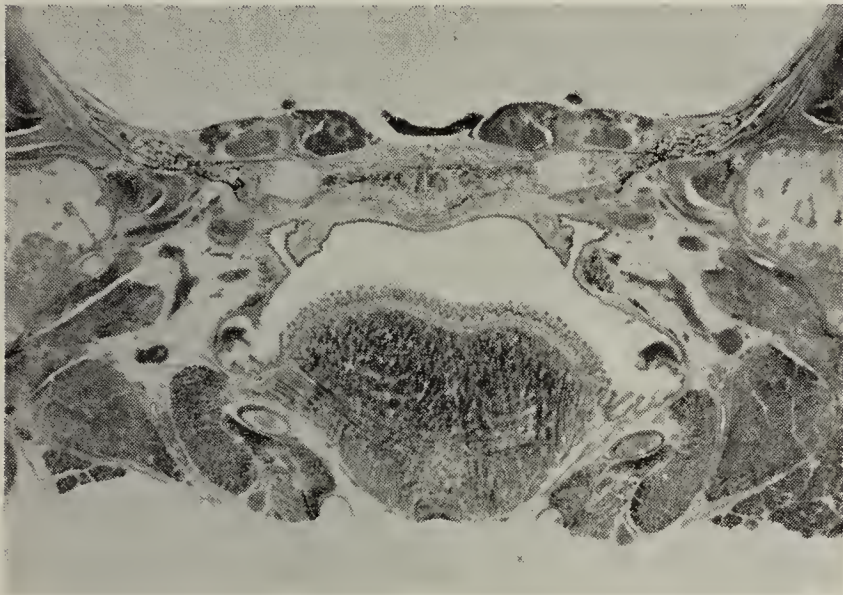


Fig. 13.—A section through the soft palate of a cleft specimen at the level of the Eustachian tubes.

showed a marked reduction in osteoblastic activity. The upper part which curves around the base of the nasal septum was normal in appearance.

In the posterior part of the palate the effect of the cleft in association with the tongue is to bring about a divergence of pterygoid plates. The amount of tissue present in the soft-palate area of the cleft specimens is reduced. The tissue elements seen in the non-cleft specimens were usually present, but variable in quantity and displaced to the lateral wall of the mouth. One specimen showed a complete absence of *muscularis palatini* (which is a paired muscle running longitudinally on either side of the mid-line of the soft palate) and a reduction in the number of palatine glands (*Figs. 13, 14*). The Eustachian tube (*Fig. 13*) remained patent, and at birth showed no evidence of pathological change.

DISCUSSION

The incidence of the tongue in the nose in this group of dogs with clefts of the secondary palate is high when compared with the cleft-palate dog population as a whole. In the remainder of the population collected by the author there were 18 specimens with a cleft of the secondary palate and a cleft of the primary palate on one or both sides. Of this group there was one specimen only with the tongue in the nose (on one side).

This compares with 9 specimens out of 24 in the group with a secondary cleft only.

A number of authors (Trasler and Fraser, 1963; Latham, 1966) have hypothesized as to the possibility of the tongue impeding the closure of the palatal folds during the development of the secondary palate and thus producing a cleft. It would appear, from the difference in tongue position in these two groups of dogs, that should the tongue be an agent in the production of clefts

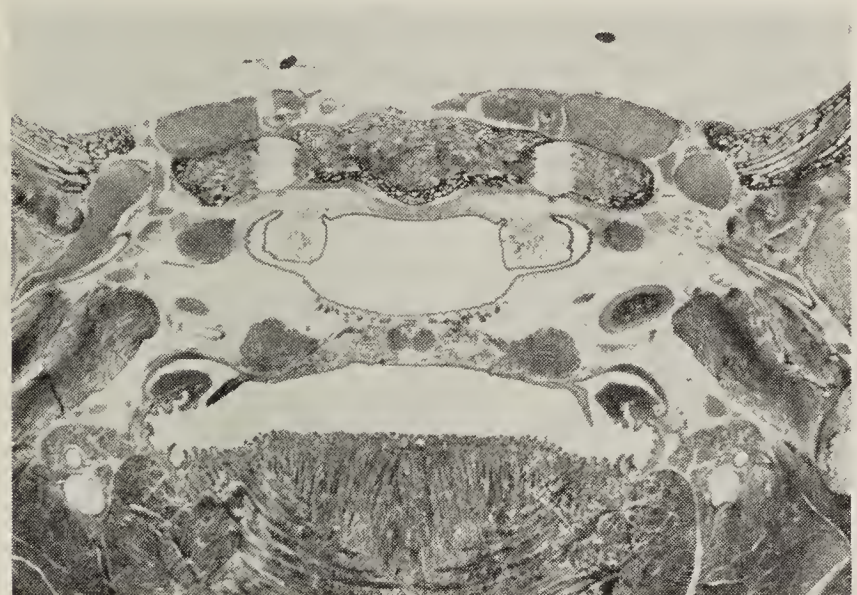


Fig. 14.—The Eustachian tube orifice and soft palate of a control specimen.

of the secondary palate that it is more likely to be active in those clefts which involve the secondary palate only.

The study of the histological and morphological appearance of the palatal shelves of the cleft-palate dog specimens shows that growth has taken place and is still continuing at birth at the margins of the shelf. The direction of growth is related to the position of the tongue, for when the tongue is in the nose the direction of the shelf is downward and inward and when the tongue is in the mouth the direction is horizontally and slightly upward.

It seems from the study of specimens not showing the typical pattern of growth described above that it is the tongue which dictates the direction of growth at this age. The group of 6 premature specimens identical in most respects showed a difference in tongue position. In 2 specimens the tongue was on the floor of the mouth, in 2 in the nose on both sides, and in 2 in the nose on one side. One of these latter specimens showed a change in direction of the shelf margin (*Fig. 11*) which is interpreted as being caused by the recent descent of the tongue into the floor of the mouth. This group appears to show a movement of the tongue from the nose into the mouth which may have already occurred in many other of the specimens examined and an adjustment of the shelves to that movement.

More important perhaps is the possibility of the tongue by its position impeding the growth of the

margin of the shelf. Only one specimen showed any evidence for this (*Fig. 12*). This specimen presented with an incomplete bilateral cleft of the primary palate (completely cleft on the left and a partial hare lip on the right) and a complete cleft of the secondary palate. There was no reason to suppose that both sides would not have achieved the same dimension if the upper surface of the tongue had not pressed against the right shelf along the greater part of its length, thereby reducing the width of the shelf by half.

These findings are of significance to clinicians treating the newborn cleft-palate baby, and in particular to those using presurgical treatment techniques. Subtelny (1955) shows that in 25 per cent of babies with clefts of the secondary palate the shelves in the palatine region are directed downwards. The placement of a plate in the mouth during the presurgical treatment of this type of patient, thereby excluding the tongue, may well cause the direction of growth of the shelves to be altered so that they assume a more horizontal position. Furthermore, the exclusion of the tongue should eliminate any possibility of that organ reducing the growth of the shelf and allow the growing edge to achieve its full potential. It is also apparent that if the design of the plate is such as to pass between the margins of the shelf into the nose to achieve expansion or retention, then this may cause a reduction in the rate of growth of the shelf margin.

SUMMARY

When there is a cleft of the secondary palate in the newborn dog, the tongue may lie in the floor

of the mouth or above the palatal shelf and in the nose. It is more common to find the tongue in the nose in dogs with a cleft of the secondary palate only than in dogs with a primary and secondary palate cleft. If the tongue lies in the mouth, then the palatal shelf is horizontal in position and if the tongue is in the nose the shelf is positioned in a ventral (downward) direction. The cleft is wider when the tongue lies in the nose, but in all cases there was a divergence of the pterygoid plate and hamuli. One shelf showed a marked reduction in its development which was assumed to be because the upper surface of the tongue impinged on the growing margin. Another shelf showed a change in direction of growth which was attributed to the tongue moving from the nose to the mouth on that side. These findings are of significance to those clinicians who use presurgical orthopaedic appliances for the treatment of cleft-palate babies.

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A METHOD OF PRODUCING BODILY MOVEMENT OF INCISOR TEETH

M. S. BERMAN, M.D.S. (Rand), L.D.S. R.C.S.

Eastman Dental Hospital

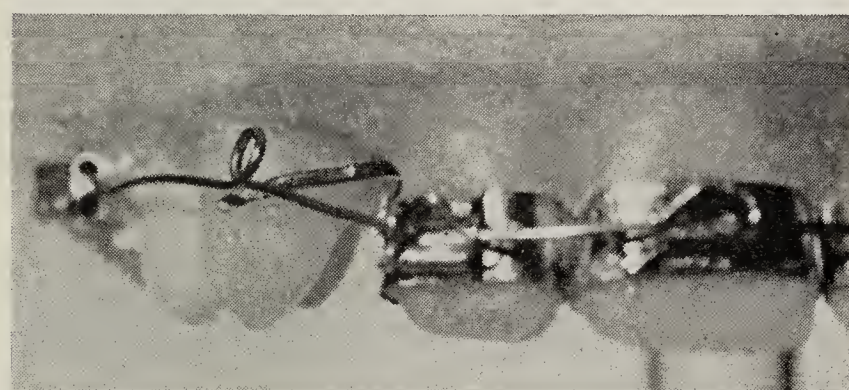
N. UPSON, L.D.S., D.Orth. R.C.S.

THERE are times during the retraction of the upper labial segment when it is necessary to effect labiolingual control over the roots of the incisor teeth.

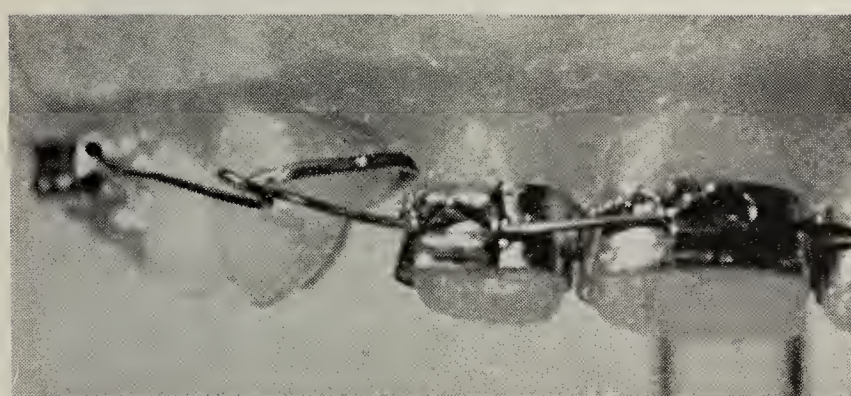
are linked by an 0.018 in. round wire. Anterior crimps produced by a pair of Howlett pliers, made to coincide with the centre of the brackets, provide the torquing action.



A



B



C

Fig. 1.—A, The type of crimps made by the Howlett pliers. B, The apex of the crimp overlying the gingival ridge of the bracket. The arch has not been tied in. Note the traction hook which is vertical. C, Note the buccal deflexion of the traction hooks after ligation.

This tooth movement, at best, is not very successfully managed with removable appliances.

Of the fixed appliances, the Johnson twin arch, although purporting to produce bodily movement of incisor teeth, by virtue of twin wires in the vertical plane, is not efficient. The Edgewise appliance with the torquing effect of its rectangular archwires; the Watkin pin-and-tube appliance, and the Begg anterior torquing auxiliaries can all be usefully employed in achieving the desired tooth movement.

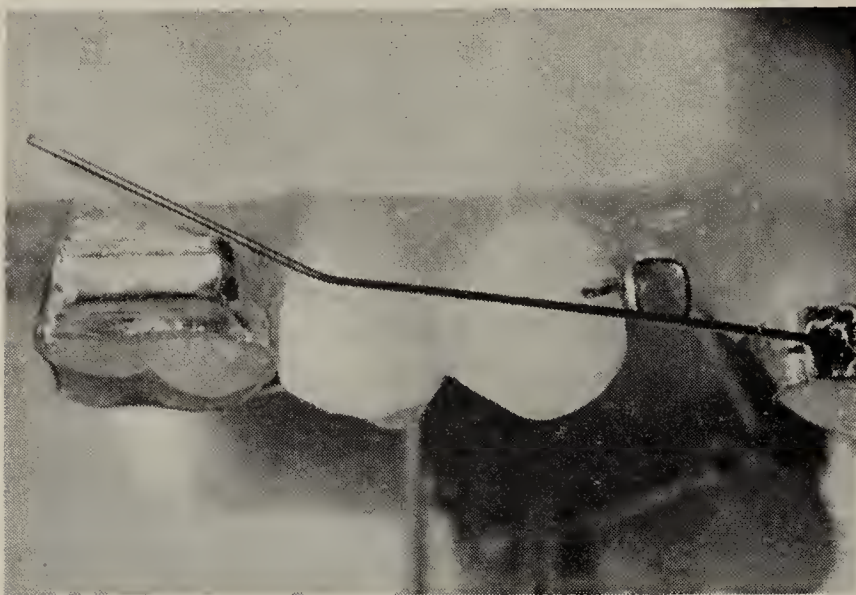
In 1962 Nahoum evolved a method which appears to be helpful, simple, and by no means time-consuming. The appliance consists of molar bands carrying buccal tubes and Edgewise brackets on the four anterior teeth. These bands



Fig. 2.—Diagrammatical drawing showing crimp lying passively within the ripple bracket.

The Howlett pliers were originally designed to produce crimps on the twin arch in order to bind it within the end tubes. One beak has a

triangular ridge running along its entire length; the other has a triangular groove into which the ridge fits, when the beaks are brought together. Applied to a round wire it produces an open triangular crimp, and, at the same time, maintains the free ends of the archwire on either side of



A

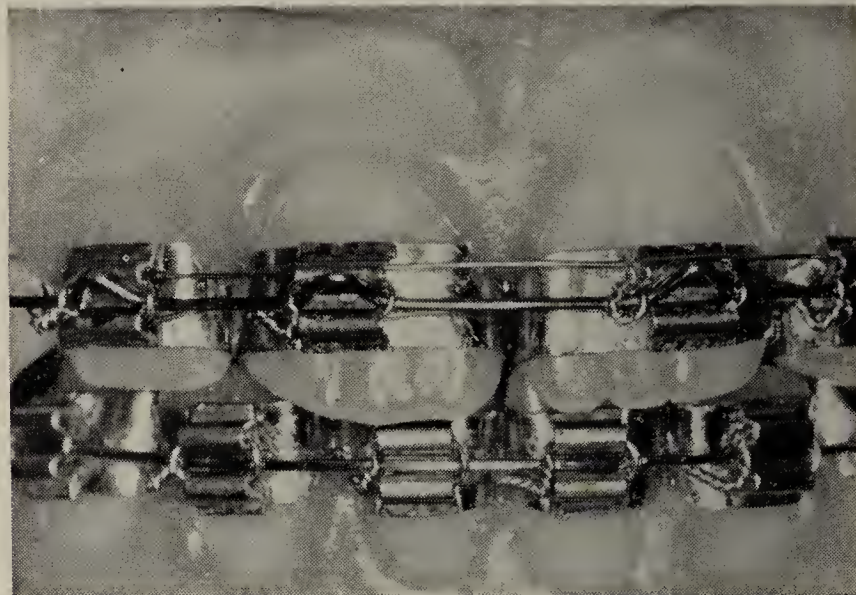


C

the crimp, on the same horizontal plane (*Fig. 1 A*). It should be pointed out that, frequently, only the central incisors require to be torqued, in which case lateral incisor crimps are unnecessary.

The Nahoum technique was introduced to the Orthodontic Department of the Eastman Dental Hospital, with the Edgewise brackets substituted by ripple brackets. Molar bands carry double buccal tubes—an occlusal 1.125-mm. buccal tube for extra-oral support, and a gingival 0.9-mm. buccal tube to receive the archwire. A curve is wiped into a length of 0.018-in. high tensile wire which is placed within the buccal tubes. A mark is made opposite the centre of the left lateral incisor bracket and the arch removed. Over this mark, the first crimp is made. The wire is reinserted and the left central incisor mark is made $\frac{1}{3}$ mm. mesial to the centre of the bracket. This makes an allowance for the length of wire which will be taken up by the distal limb of the succeeding crimp. The same procedure is

carried out for the remaining two teeth. Vertical traction hooks are bent into the archwire opposite the upper canines, and at this site, or opposite the second premolars, 30° anchor bends are incorporated. The anchor bends fulfil three functions: (1) They assist in anchorage, by



B

Fig. 3.—A, An archwire with 45° crimps ligated in. Note position of the free end in relation to the buccal tube. B, An anterior view of an active Nahoum appliance. C, An archwire with crimps at 25° to the vertical. Note position of the free ends related to the buccal tube.

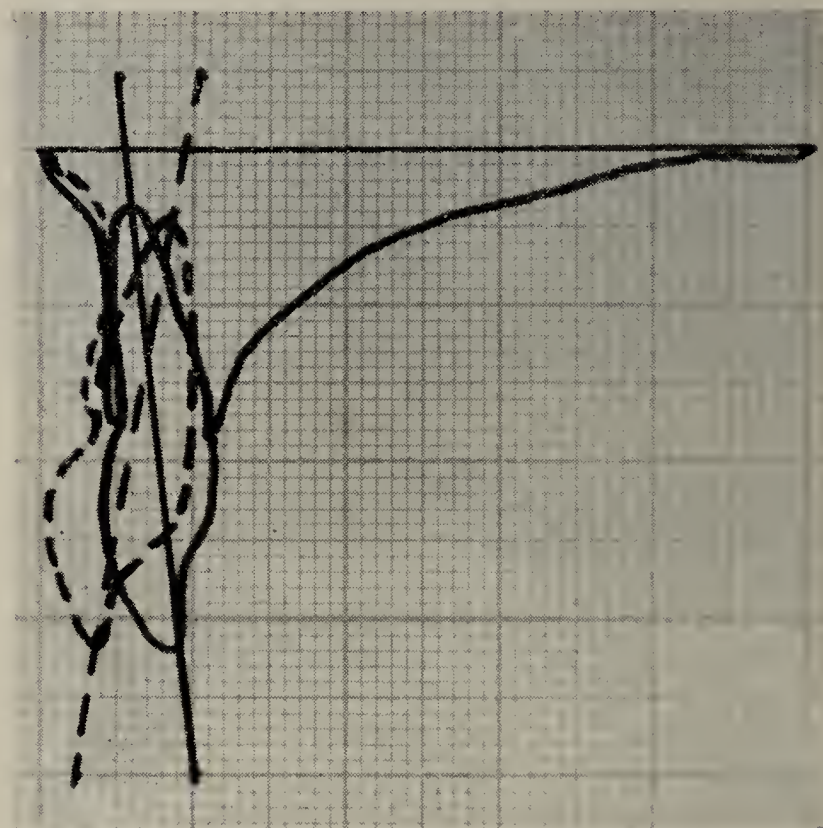


Fig. 4.—The effect of a simple tipping force transmitted to the incisors. The dotted outline indicates the original position of the tooth. The solid outline the ultimate position.

virtue of the distal crown tipping action upon the molars; (2) They aid bite opening, by producing an intrusive effect upon the labial segment; and (3) theoretically they increase the torquing effect of the appliance.

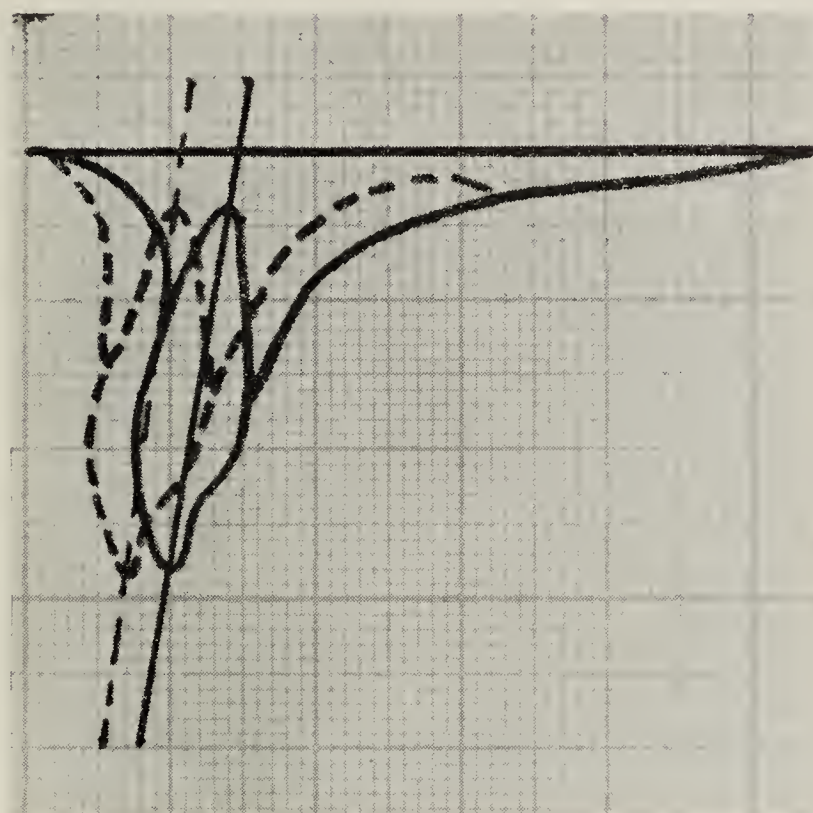
Effectiveness of this technique is determined by the alinement of the crimps, so as to produce a torquing effect upon the teeth. The crimps are made in the vertical plane, with the apex of the triangle pointing upwards and overlapping the centre of the gingival ridge of the ripple bracket.

When the archwire is tightly ligated into the brackets, pressure is directed against this gingival ridge. Because the sides of the base of the triangular crimp are embraced by the ligature tie, a lingual torquing action on the roots is obtained. The torquing effect is well illustrated in *Fig. 1B*, and *C*.

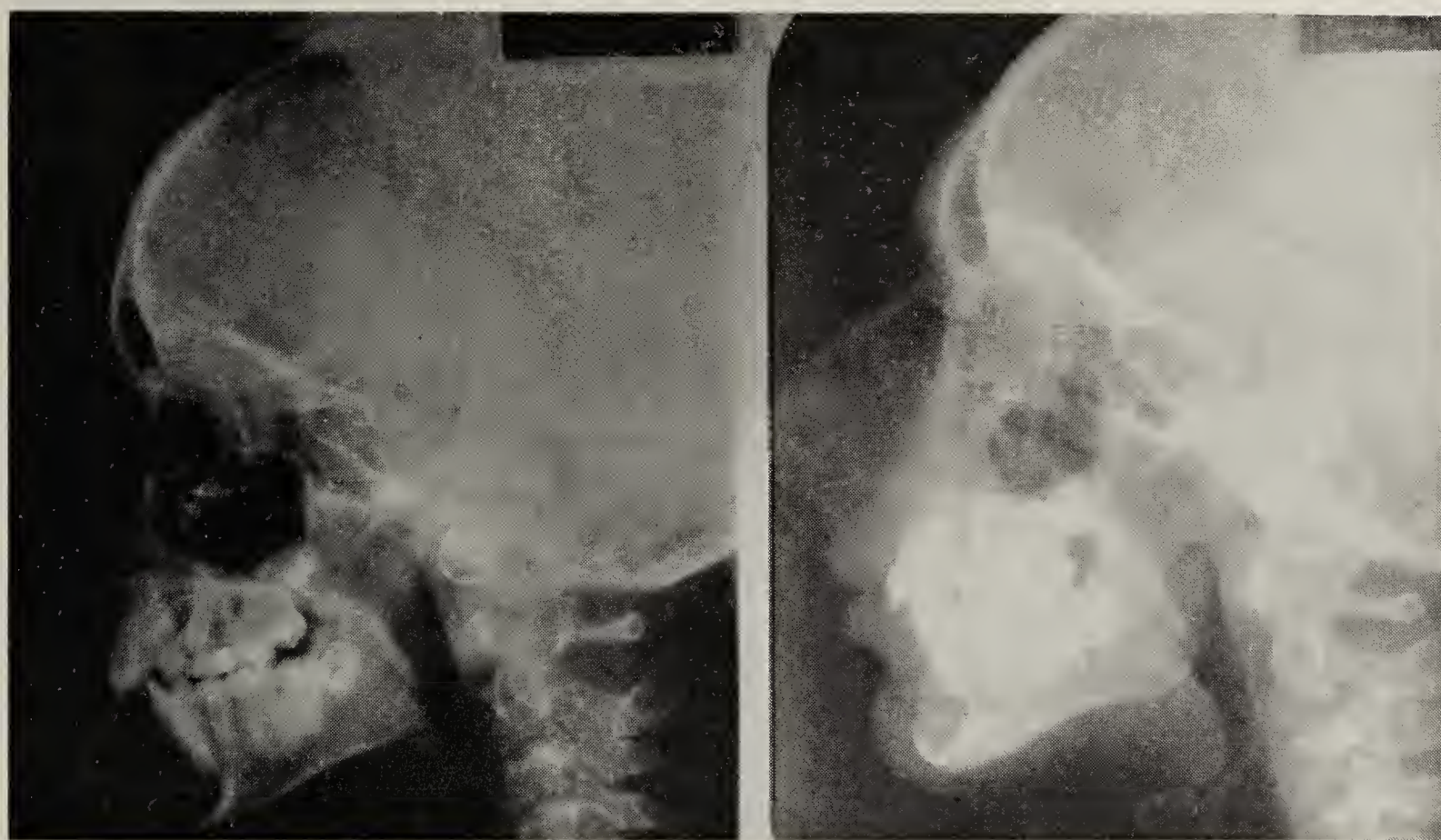
It follows, of course, that a reciprocal labial action on the crowns is produced. However, if a retractive influence by horizontal or Class II elastics is brought to bear upon the archwire, at the worst, the overjet will not increase and, at the best, it will be reduced.

The Nahoum torquing archwire is customarily inserted after the canines have been retracted and the anterior spaces closed. At this time, a palatal arch is inserted to retain the position of the canines and to assist in anchorage during the retraction of the incisor teeth.

horizontal elastics may be applied if extra-oral support is given. During the day a lighter elastic force is worn. This latter force should be



A



B

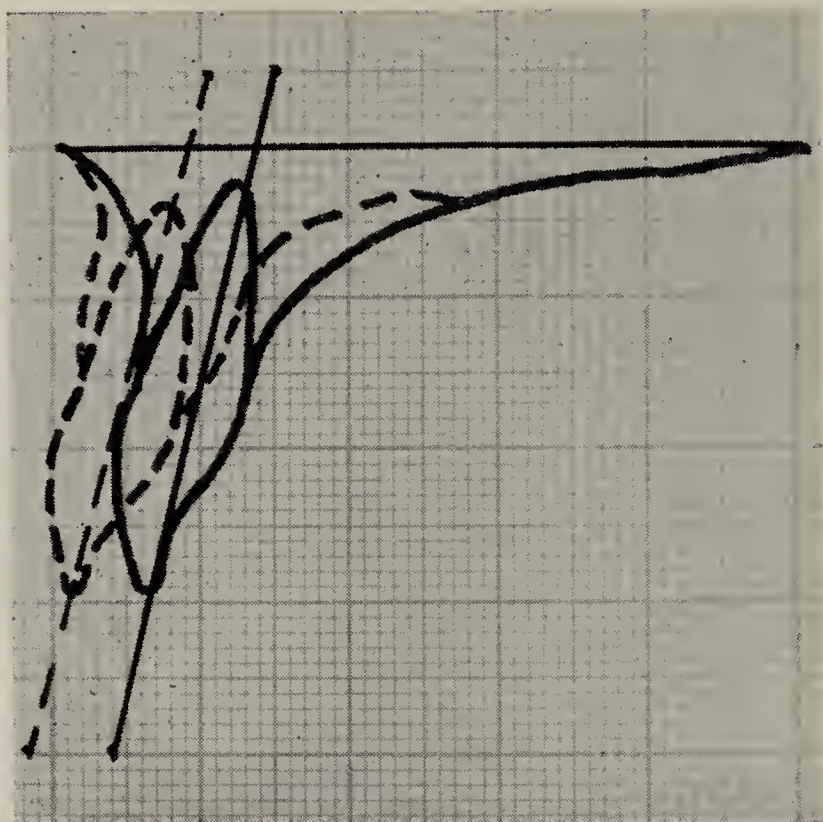
Fig. 5.—Case 1. A, Apical change 4 mm. Crown change 3 mm. Dotted outline the original position. Solid outline the ultimate position. B, Radiographs before and after treatment.

The archwire is ligated to the brackets and Class II elastics, where the lower arch permits it, or horizontal elastics are used. It is essential that a twenty-four hour retractive force be applied, otherwise the overjet may increase as the crowns of the incisor teeth are moved labially. Strong

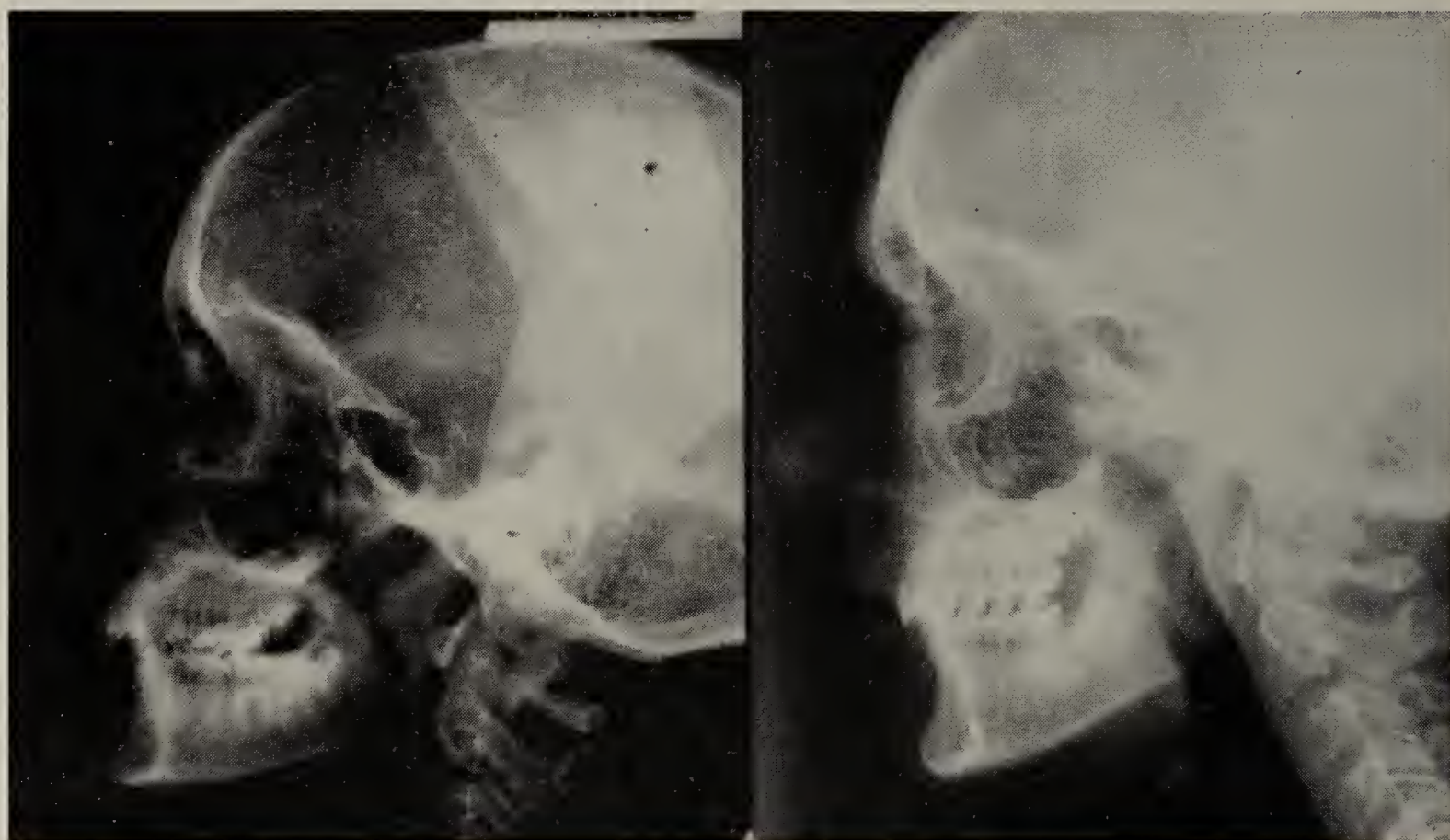
sufficient at least, to prevent the overjet increasing and yet not cause too much strain on the barely adequate anchorage afforded by the palatal arch.

The torquing action is relayed to the distal free ends of the archwire and translated into a

lateral deflexion. This would cause the first molar teeth to move buccally. In the presence of a palatal arch, this would not occur, but, in its absence, to obviate buccal expansion, a



A



B

Fig. 6.—Case 2. A, Apical change 4.5 mm. Crown change 5 mm. Dotted outline the original position. Solid outline the ultimate position. B, Radiographs before and after treatment.

considerable narrowing of the arch from the traction hook backwards, must be introduced.

If the canines and premolars are banded, closing loops instead of elastic traction may be used. This would have the advantage of an assured continuous force, but may tax the

anchorage. Clinical judgement dictates the method of choice.

Because experience has shown that the Nahoum method appears more readily to produce bodily movement rather than apical movement, it follows that the approach to the retraction of incisor teeth should run counter to Begg's (1965) method, where the teeth are primarily tipped back and then uprighted. We prefer to initiate bodily retraction from the word go.

There are a number of factors which influence the efficacy of this appliance. The first factor is the relation of the crimps to the brackets. The depth of a ripple basket is 2 mm. Thus, if the crimp were to lie passive within the bracket, it would be at an angle of 45° to the long axis of the tooth. This is illustrated diagrammatically in Fig. 2, and in Fig. 3A it is shown clinically. The archwire, with central incisor crimps, has been ligated to these teeth. The position of the free ends indicates that the main archwire would lie passively within the buccal tubes.

If this angle of 45° were decreased by 20° , it would have the equivalent effect of, say, a Begg anterior auxiliary arch bent at 20° to the lingual. When these crimps are thus activated, and ligated

to the incisor teeth (Fig. 3B) and the archwire left free of the molar buccal tubes, it is seen that the archwire lies gingival to the molars (Fig. 3C). As the angle of the crimp to the long axis of the tooth narrows, the gingival deflexion of the free ends of the archwire becomes greater. If this

archwire were placed in the buccal tubes, a torquing effect upon the incisors, relative to the degree of angulation of the crimps, would be produced.

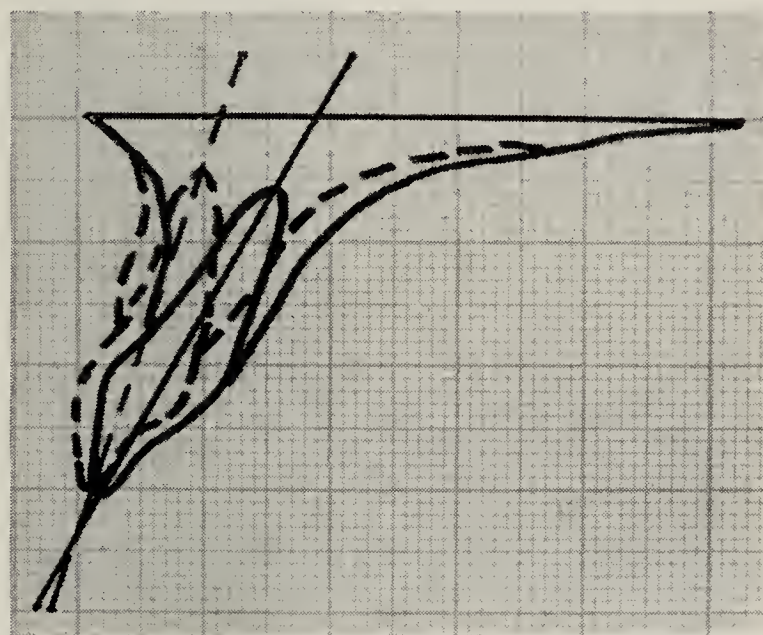
The second factor conducive to root control with the Nahoum method is the tightness of the ligature tie. Although a considerable amount of force is achieved by using the edgewise ligature-locking pliers, some of this is lost, and its effectiveness limited, by the degree of stretch of the ligature wire.

The third, and an elusive factor, is the amount of restraining force necessary to overcome the concomitant labial movement of the crowns of the teeth. This intramaxillary or intermaxillary force is of necessity an arbitrary one, as there is no adequate means of measuring the resultant of the forces used, or locating the point of rotation, whatever the torquing method.

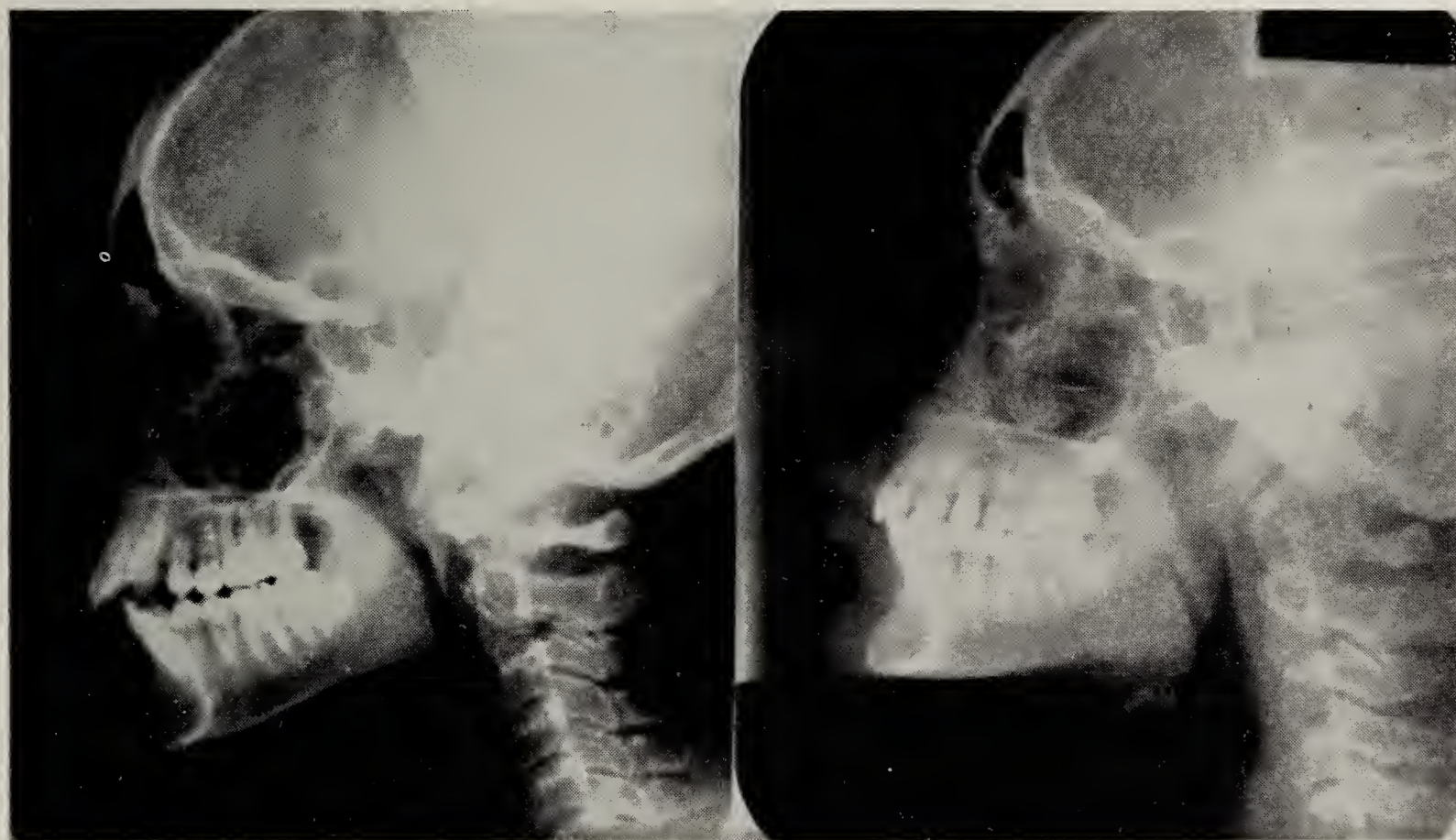
Theoretically, if the reciprocal effect upon the crown is exactly cancelled out, the resultant force should produce lingual apical movement, with the tip of the crown remaining stationary. If the retractive force is increased, one would expect to

In actual practice, a modicum of clinical judgement is all that is necessary to produce nuances of response.

Five cases are presented showing the full range of labiolingual root control, from lingual crown tipping, with the point of rotation about the apex, through to apical palatal movement,



A



B

Fig. 7.—Case 3. A, Apical change 6.5 mm. Crown change 1.5 mm. Dotted outline the original position. Solid outline the ultimate position. B, Radiographs before and after treatment.

get some reduction in overjet and eventually so-called bodily movement. As the force is stepped up, lingual crown movement increases to a stage where the point of rotation is about the apex. Ultimately, carried to its logical conclusion, the total gamut of labiolingual movement runs its course, and we are back to square one—tipping!

with the tip of the crown remaining stationary.

Lateral skull X-rays were taken just before the Nahoum arch was placed and at the time of its discontinuation. Tracings were made, superimposing upon the maxillary plane and registering on A.N.S. The outline of the labial and palatal plates was included, together with the template of the central incisor (see Figs. 5–9).

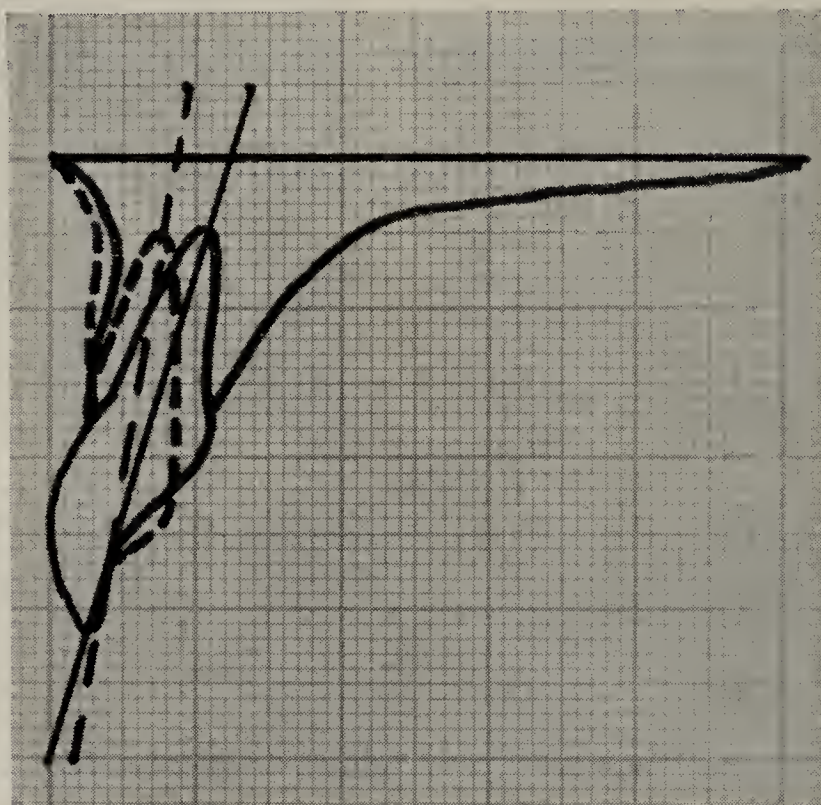
Before discussing the cases treated by this method, a typical result of the effect of a tipping force used to reduce an overjet (in this instance a flexible labial bow) is illustrated (*Fig. 4*). The crown has been tipped back 6° and the apex has moved forward 3° . The angle of upper central incisor to occlusal plane was reduced from 98° to 80° . This retroclined labial segment could produce an aesthetically unacceptable result.

For this reason, a method providing labio-lingual incisor root control during the reduction of overjet is desirable.

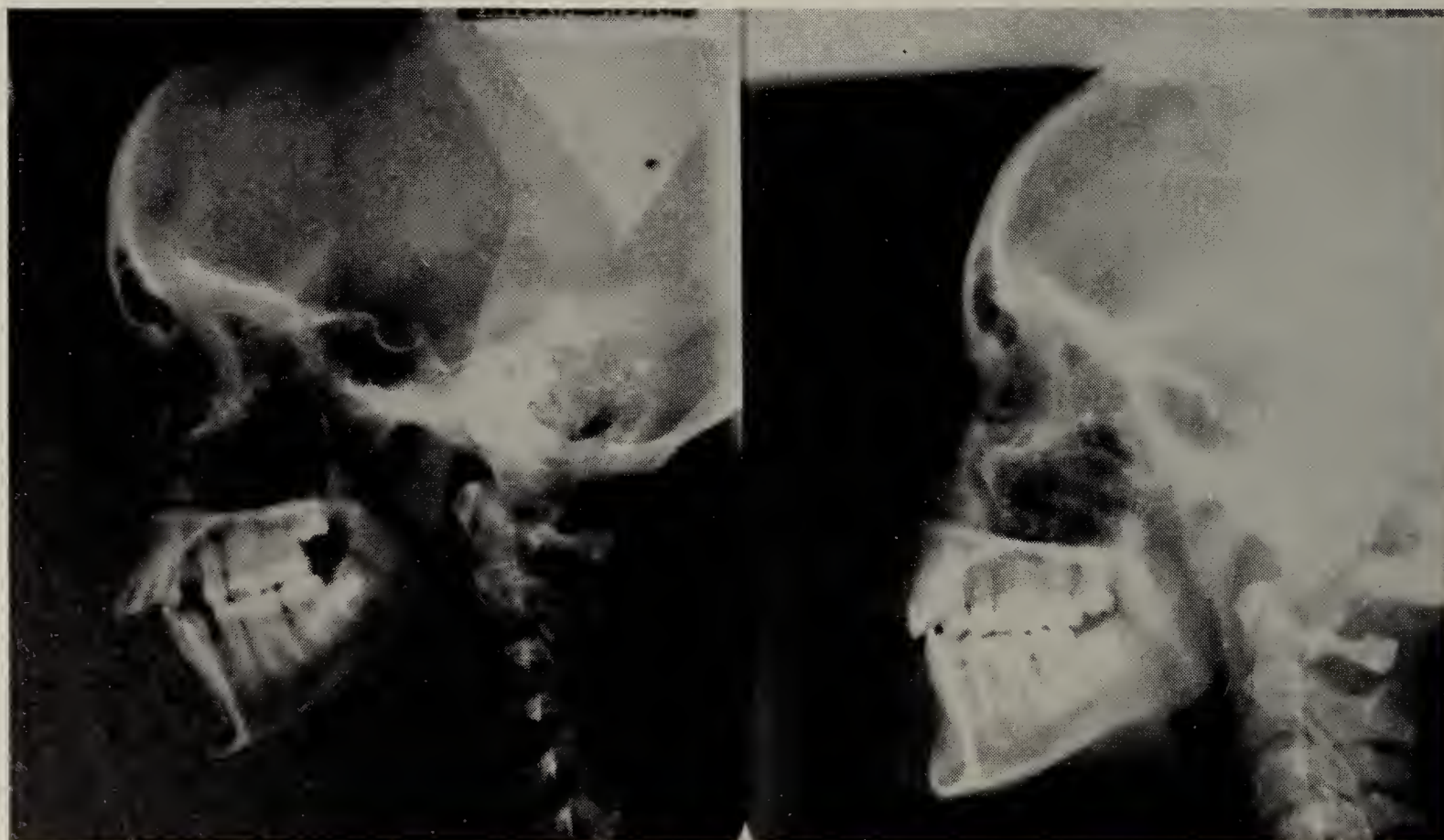
The object of this paper was to introduce to those who are not acquainted with the technique, a method that is uncomplicated, relatively efficient and one that requires no great degree of expertise. It may prove to be a useful additional tool.

Acknowledgements

Our thanks are due to Professor C. F. Ballard for allowing us to use the material presented and putting at our disposal the facilities of the department; the members of the Photographic

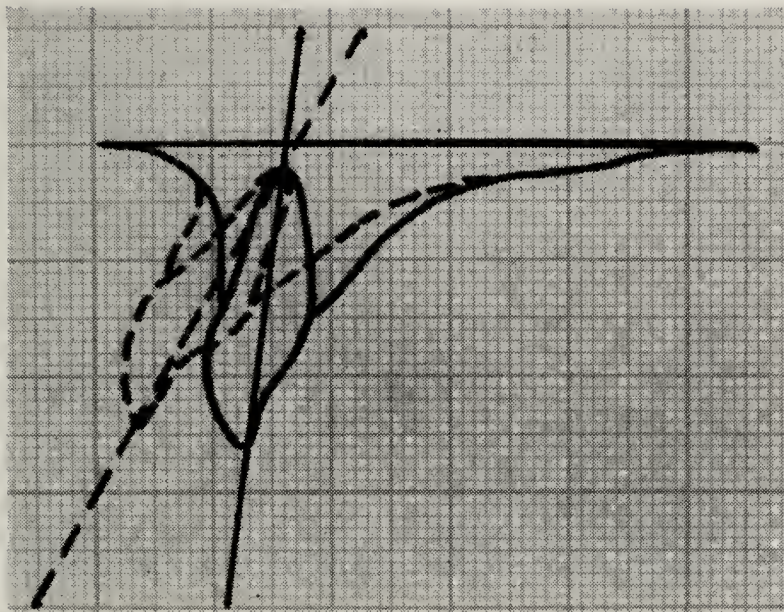


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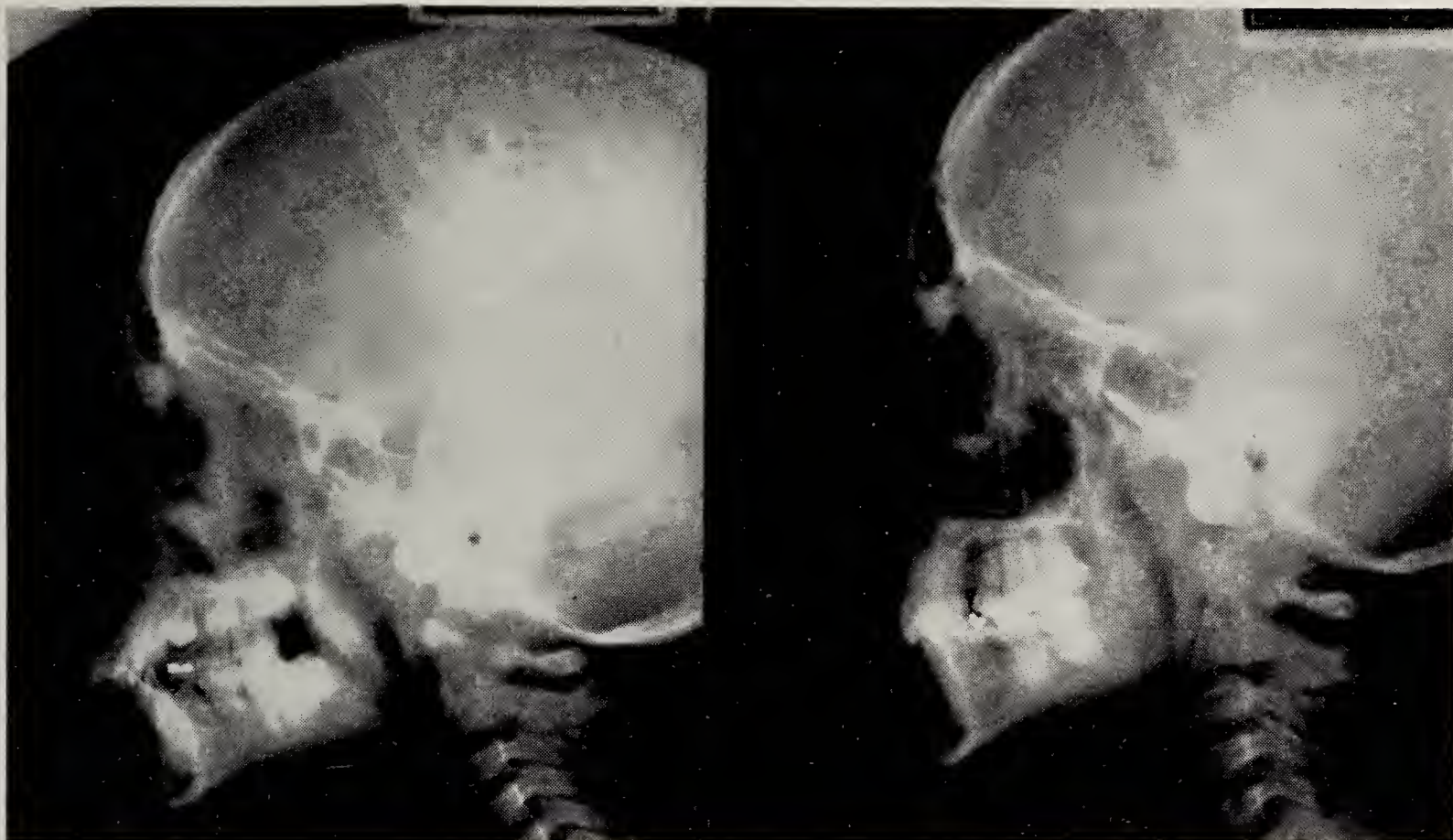


B

Fig. 8.—Case 4. A, Apical change 4 mm. Crown change nil. Dotted outline the original position. Solid outline the ultimate position. B, Radiographs before and after treatment.



A



B

Fig. 9.—Case 5. A, Apical change nil. Crown change 9 mm. Dotted outline the original position. Solid outline the ultimate position. B, Radiographs before and after treatment.

Department of the Eastman Dental Hospital, and Miss Jeffery, who typed this paper.

CASE REPORTS

Case 1

The first of the cases treated with the Nahoum arch shows what one would describe as bodily movement (Fig. 5A). An overjet of 4 mm. has been reduced without any alteration of the axial inclination of the incisors. If this overjet had been reduced by simple retraction, resulting in tipping, then the appearance might have been something like the previous case (Fig. 4). Before and after radiographs show the overall change, which is perhaps more impressive.

Case 2

The second case is a similar one—again one of bodily movement (Fig. 6).

Case 3

The third case again shows bodily movement with perhaps a more significant degree of apical movement (Fig. 7).

Case 4

The fourth case proves that the Nahoum appliance can, after all, achieve pure apical torque with no concomitant movement of the crown. This is what Begg does and probably does better than the Nahoum (Fig. 8).

Case 5

Finally, Fig. 9 illustrates a reduction in overjet of 9 mm. with the point of rotation about the apex.

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DISCUSSION

Dr. J. R. E. Mills thanked Mr. Berman for his paper and even more so for introducing him to the appliance at the Eastman Dental Hospital two or three years ago. It was a very simple method, and fitted in with the technique that many of them used. When one came to tie it in to the brackets it was extremely important to make sure that it was tied really fully home. He found that if it were not tied quite home the anterior teeth would rotate. Had Mr. Berman had the same experience?

Mr. Berman, in reply, said that he had had this experience initially when starting to use the method due to using too much force by having the crimps at right-angles to the horizontal plane. He had used (as he did now) ligature locking pliers producing considerable force. With the crimps lying at 30° to the vertical there was less danger of individual variations in response and each bracket could be activated equally.

Mr. R. J. Thomas asked whether it helped to put inserts mesial and distal to $\frac{2}{2}$ in order to control these teeth.

Mr. Berman, in reply, said that he would rather place lateral 'step-in' bends when apical torque had been completed.

Mr. D. D. Di Biase asked whether Mr. Berman had observed any resorption of the roots of the teeth undergoing torque and whether this was of any significance.

Mr. Berman replied that he was always seeing this, but was not sure of the cause. He believed that one of the contributory factors which caused root resorption was tipping. This action would throw the apices of the incisors forward against the labial plate. Also if one put on too much force to achieve apical movement there was a greater tendency for root resorption, but he could not be dogmatic.

Mr. J. S. Beresford assumed that the archwire was bent up, say, in the horizontal plane, in a curve. On inserting the crimps did the author turn the pliers up at 30° or 70°, or keep them in the same plane as the archwire and turn the ends up afterwards?

Mr. Berman said that he held the pliers at 30° or 40° to the vertical according to the type of tooth movement required. With experience, this judgement was not difficult. Each crimp is made parallel to its neighbour, by holding the pliers at the same angle.

Mr. B. C. Leighton said that it was some time since he had read Dr. Nahoum's original paper but he believed Dr. Nahoum had mentioned that he found it was gentler for the teeth to put crimps on alternate teeth, in order that the length of wire in torque should be less.

Did Mr. Berman ever retract the centrals first and then the laterals? He was rather encouraged to ask this because on one of the slides the centrals had crimps and the laterals appeared not to have them. Also, were the canines ever engaged?

Mr. Berman said that very often one only required to torque central incisors. This was true with the Begg technique too. But if he wanted to torque all four teeth he would place crimps on all the incisors and not two at a time.

Mr. P. R. Coyle asked what forces Mr. Berman was using with his intra-oral traction during day-time and night-time.

Mr. Berman said that the amount of force used was a matter of pure judgement and varied from case to case. He did not use much more than a 4-ounce elastic force at night, and in the day no more than about 2 ounces. As long as the patient was seen fairly frequently it could be controlled, but he did not like to use more than 2 ounces of intermaxillary elastic force.

Mr. W. B. Senior asked how frequently Mr. Berman saw the patients for adjustments.

Mr. Berman replied that with all the multiband techniques he saw his patients every three weeks.

Mr. B. H. Miller asked whether Mr. Berman was able to take the whole apical movement through with the one archwire and if so was it necessary to adjust the activation from time to time.

Mr. Berman thought it was possible to use the same arch all the way through, depending on what one wanted to achieve. If the overjet increased an adjustment might be needed. It was not a question of adjusting the crimps, the original arch was discarded and a new one made. The arch was simple to make and was by no means time consuming.

Mr. C. D. Parker asked whether Mr. Berman had noted any change in the angulation of the molars with the use of this appliance.

Mr. Berman said that usually he had a palatal arch in and that prevented it. He had noticed that without this palatal arch the molars did tend to tip.

MODIFICATIONS OF STANDARD APPLIANCES II

J. R. E. MILLS, D.D.S., M.Sc., F.D.S., D.Orth. R.C.S.

Institute of Dental Surgery, University of London

THE OVER-ROTATION OF ANTERIOR TEETH

ROTATED anterior teeth can be relatively easily aligned with fixed appliances. The difficulties arise due to their strong tendency to relapse. This tendency can be reduced if the rotation is continued beyond the correct position so as to produce some degree of over-rotation. A method of producing this was shown in a previous paper (Mills, 1959), but this method had the disadvantage that the bracket and incisor band had to be modified. The method here described does not involve any modification of the band. The idea originated from the well-known Steiner rotation spring wedge, although it bears only a distant resemblance to that device.

The earlier stages of treatment are conventional. Adequate space is made to align the rotated teeth and these are then brought into line using an archwire, with bands on the anterior teeth carrying the Eastman ripple bracket. When the teeth have been aligned over-rotation is commenced. A short piece of orthodontic stainless-steel tubing about 3 mm. long is cut, from a stock length, using a carborundum disk. The diameter of the tubing will depend on the amount of over-rotation required, but should be of approximately 0.7-mm. internal diameter. A standard U-shaped ligature is threaded through the tubing, the tubing is placed under the archwire, and the ends of the ligature are then threaded through the ripple brackets in the conventional manner and tied over the archwire (*Fig. 1*). The effect of the tubing is to press the appropriate edge of the tooth in a lingual direction and to move the other edge labially (*Fig. 1*). If necessary, the tubing can be replaced by a larger gauge to continue the over-rotation.

The results of the use of this device are shown in *Fig. 2*. The patient had a postnormal molar relationship with crowding of the upper labial segment. This was treated by extraction of the upper second molars and distal movement of the upper cheek teeth. The upper anterior teeth were then aligned with a twin wire arch and the device here described was used to achieve the over-rotations shown in the centre picture. This was retained for 6 months in the over-rotated

position, and the final models show the condition 6 months out of retention.

This device has the advantage of cheapness and works extremely well with the twin wire arch or with light round wires.

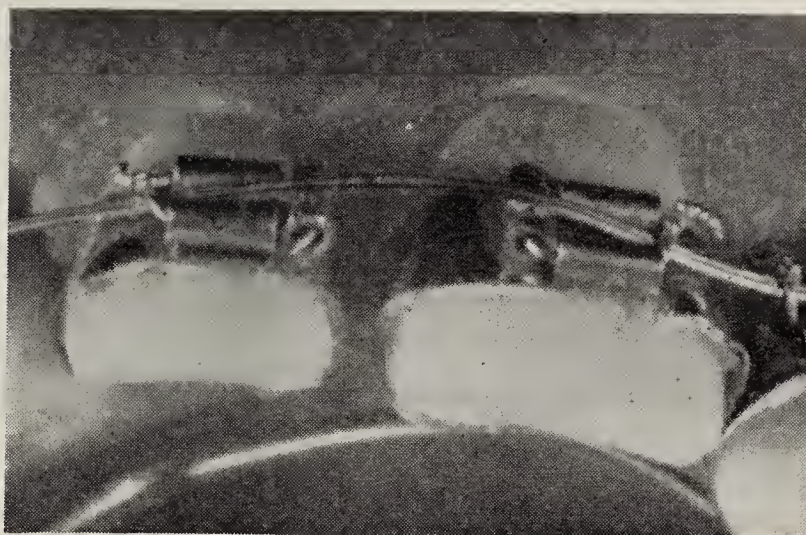
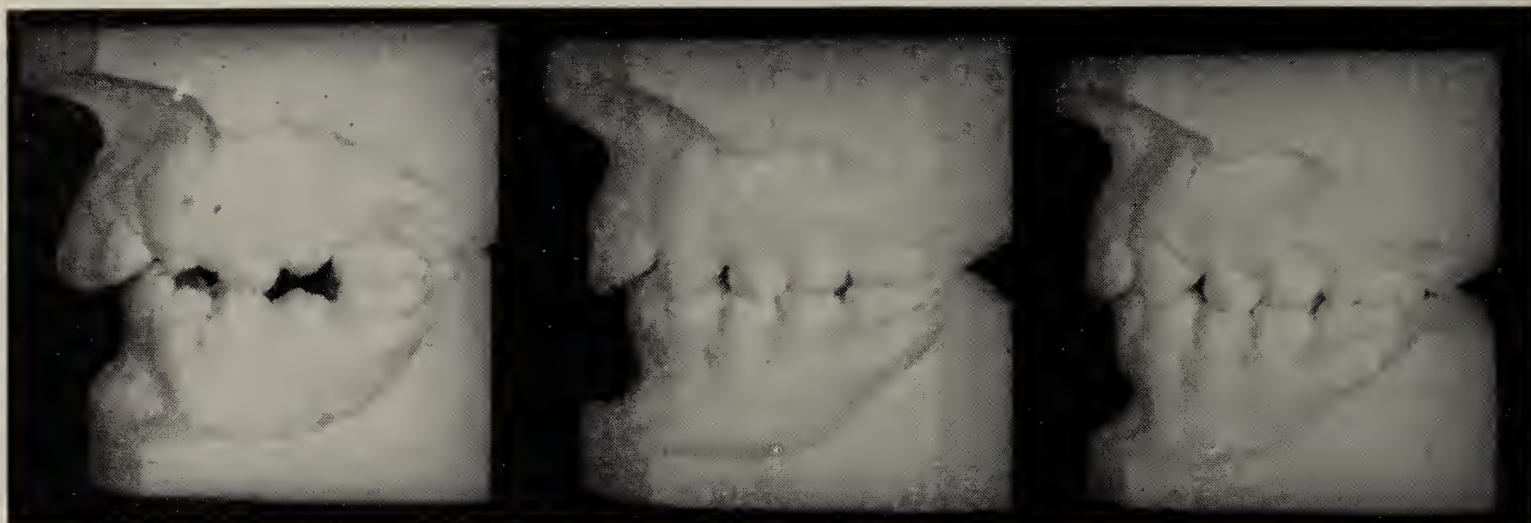


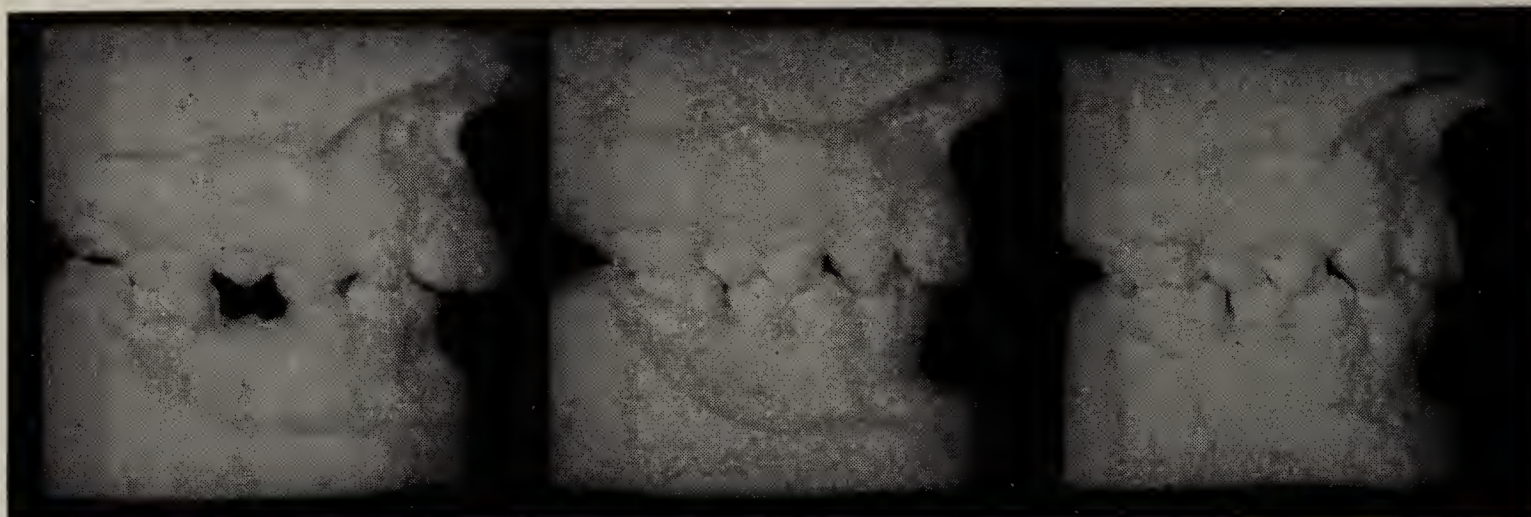
Fig. 1.—Twin wire arch on $\overline{21}$ showing use of a short length of tubing to over-rotate $\overline{2}$ mesiolingually and $\overline{1}$ distolingually.

THE PALATAL MOVEMENT OF THE UPPER INCISOR APICES

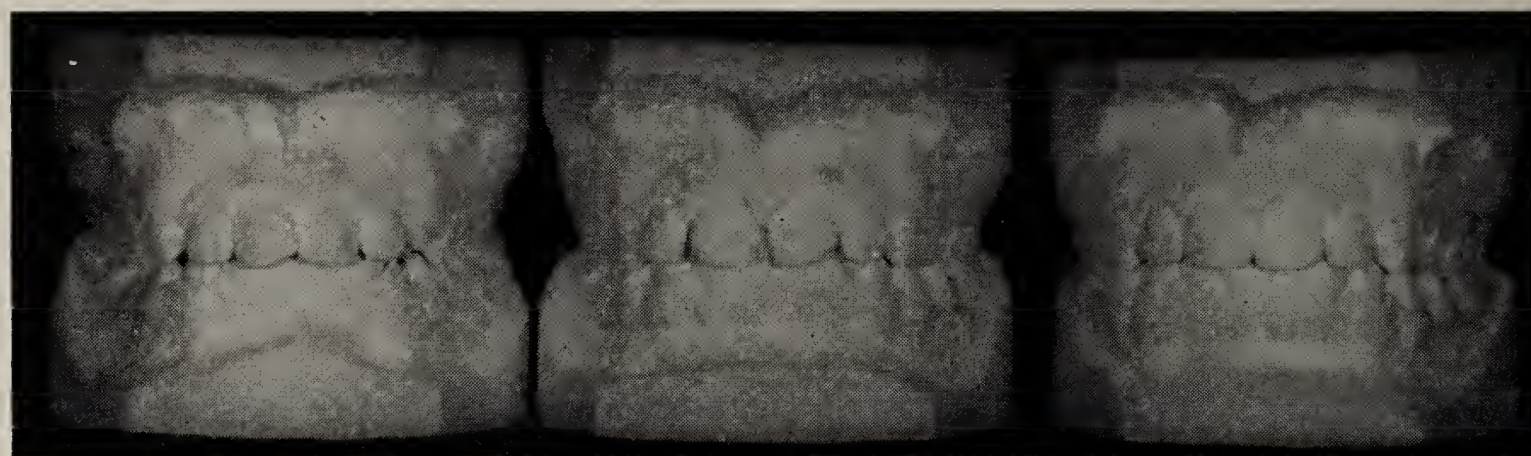
In reducing an increased overjet, in a small proportion of cases it may be necessary to move the upper incisor apices palatally in order to prevent excessive retroclination of the upper incisors. Several methods have been described for doing this, and the one which I am adding here is based on the 'pin-and-tube' or 'loop-and-tube' appliance perfected by the late H. G. Watkin. The advantage of this appliance lies in the very rigid attachment between archwire and bracket. The bracket consists of a vertical rectangular tube (*Fig. 3*) which is basically part of a modified McKeag lock. A U-shaped loop is constructed in the archwire which fits reasonably accurately into each of these tubes. It is held in position by depression of the small flange cut in the vertical rectangular tube. Aspects of the appliance have been described by Watkin (1933) and Watkin and others (1958). In 1965 Clifford described a modification of the pin-and-tube appliance using the principle of lever torque to tilt anterior teeth lingually. This



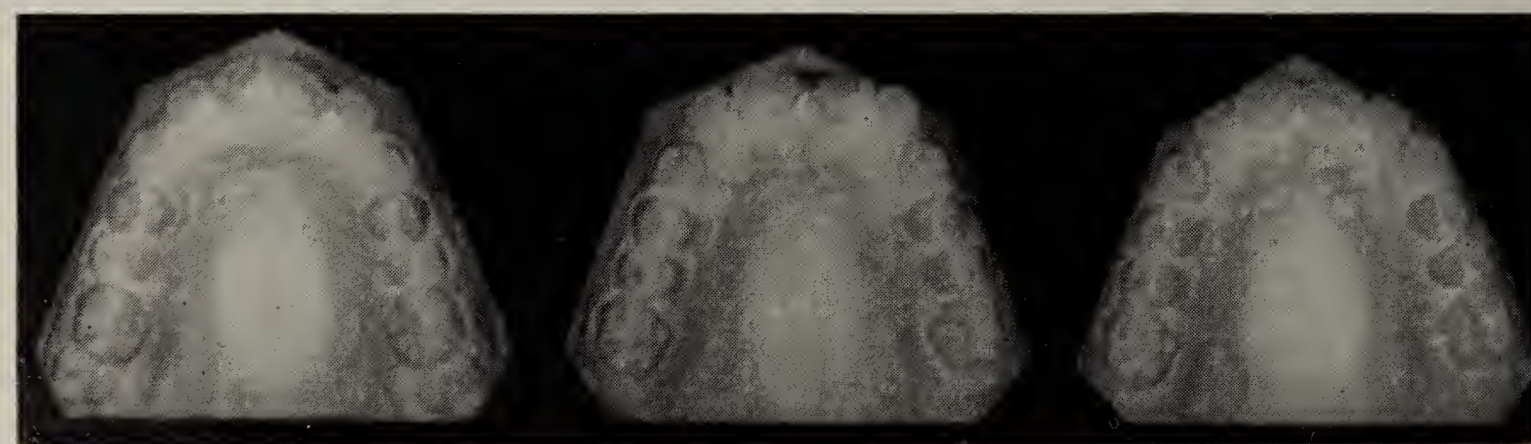
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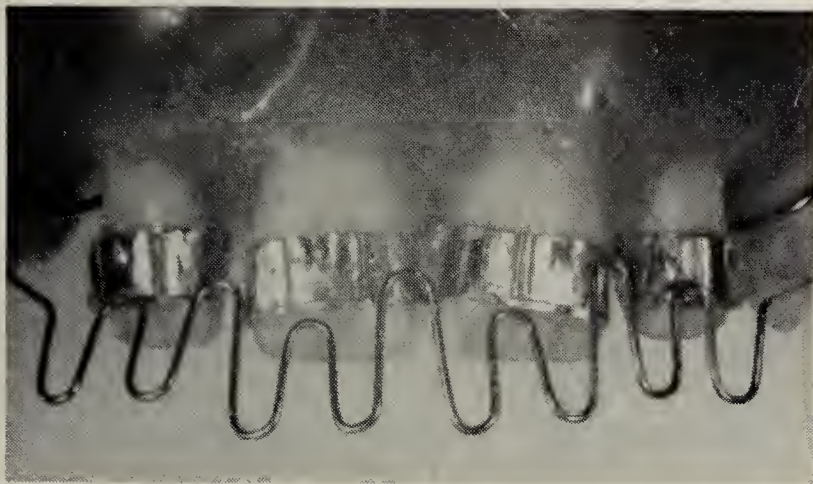


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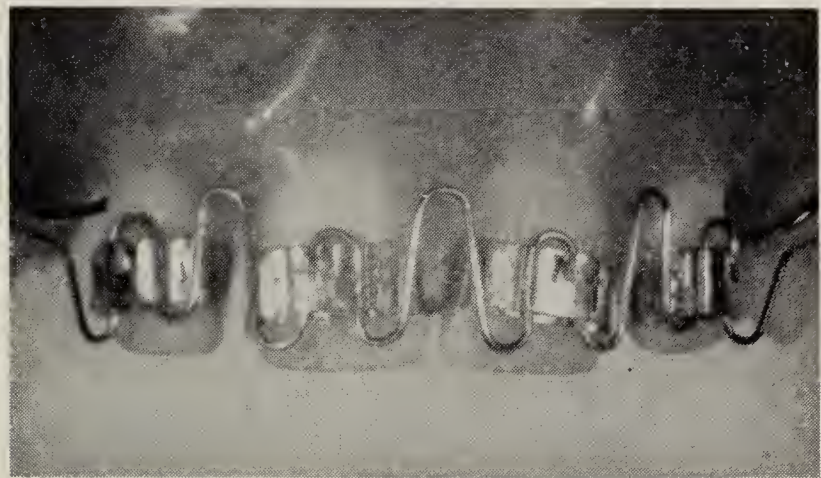


D

Fig. 2.—Models of patient on whom the device described was used to produce the degree of over-rotation shown in the centre photograph, following distal movement of upper buccal segments. The teeth were retained in the over-rotated position for 6 months, and the models on the right taken 6 months out of retention. A, Left lateral view. B, Right lateral view. C, Anterior view. D, Occlusal view of upper models.

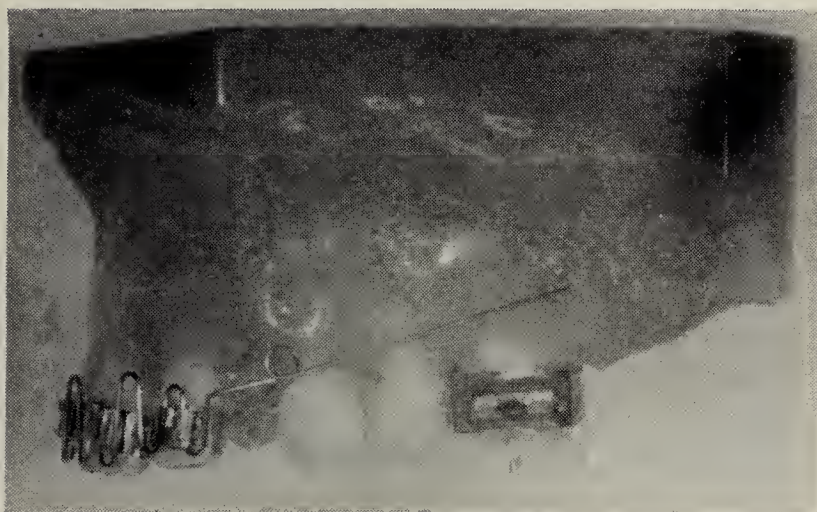


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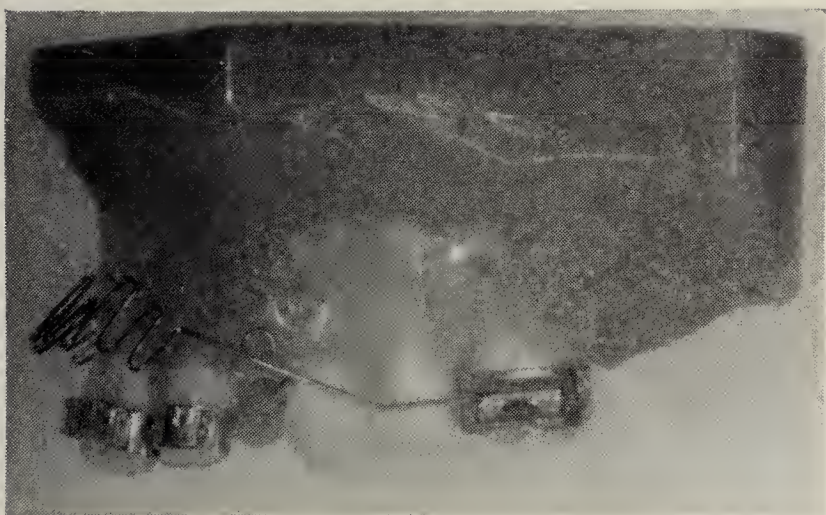
Fig. 3.—Anterior view of the pin-and-tube appliance described. A, With the 'pins' withdrawn from the 'tubes'. B, With the appliance in place.



A



B



C



D

Fig. 4.—Stages in the adjustment of the appliance to produce lingual apical movement. A, A bend is made posterior to the most distal 'pin', so that the end of the arch lies above the tube on the molar band. B, The same appliance inserted into the molar tubes, but removed from the anterior brackets. C, A bend is made 5 mm. anterior to the buccal tube if intrusion of the upper incisors is required. D, The arch is then inserted into the anterior vertical tubes, to check that the first adjustment has not been affected. E, Finally both ends of the appliance are inserted.



E

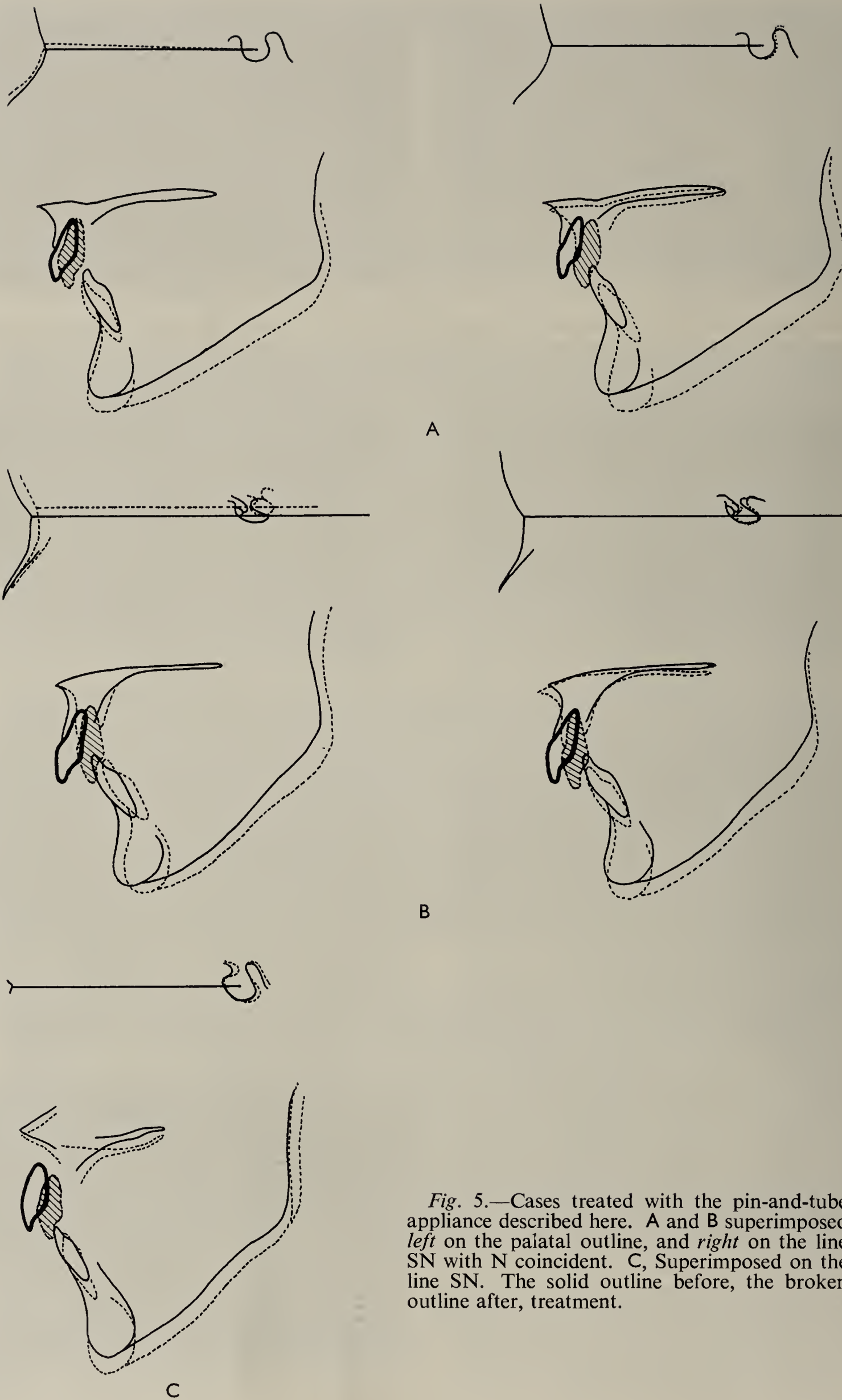


Fig. 5.—Cases treated with the pin-and-tube appliance described here. A and B superimposed *left* on the palatal outline, and *right* on the line SN with N coincident. C, Superimposed on the line SN. The solid outline before, the broken outline after, treatment.

principle has been further modified in the present appliance.

As before, the earlier stages of treatment are conventional with adequate space being made and canines retracted into a normal relationship. There is no objection to the anterior teeth becoming spaced during this stage of treatment. Bands are then made for the upper first permanent molars, the central incisors and, if necessary, the lateral incisors. The first molars will carry tubes of large diameter (say 1 mm. internal diameter) to allow free-sliding of the archwire, and it may well be necessary to have a second tube to carry a Kloehe bow for extra-oral anchorage. The bands on the anterior teeth will carry the vertical rectangular tubes referred to. The archwire is constructed from 0.45 mm. high tensile wire and the anterior segment is bent to have four vertical loops, each of which will fit into the appropriate tube, separated by rather larger loops which may be used for space closure (*Fig. 3A*). These closing loops should be included even where space closure is not required to allow final adjustments of the appliance in the mouth. A traction hook is usually necessary in the upper canine region and the posterior end of the archwire should protrude slightly through the buccal tube. When completed, the archwire should be passive in every way; the importance of this cannot be over-emphasized.

The appliance is first adjusted by bending the archwire just behind the most distal 'pin' so that, when the pins are inserted into the vertical boxes, the posterior ends of the archwire lie about 1 cm. above the tube on the first molar (*Fig. 4A*). If the appliance is now removed from the vertical boxes, and the posterior ends placed in the molar tubes (*Figs. 4B, 3A*) it will be seen that the pins are no longer parallel to the boxes, but are rather more 'proclined'. The effect of this adjustment would be to move forward the incisal edges labially or move the apices palatally, or both. Forward movement of the incisal edge is prevented by traction to the hooks in the canine region and this may be either intermaxillary or intramaxillary. The latter would normally be reinforced by extra-oral anchorage. The overall effect is, therefore, to move the incisor apices palatally. The archwire will also have an effect in the vertical dimension. If the overbite is complete, it may be desired to intrude the upper incisors and, to achieve this, a bend is made in the archwire about 5 mm. anterior to the buccal tube (*Fig. 4C*). The pins then lie considerably gingivally to the tubes and will produce a little opening of the bite. Having made this second bend, the pins must then be replaced in the tubes

with the posterior end free (*Fig. 4D*) to make sure that the original adjustment has not been affected. Finally, both ends of the appliance are inserted into their appropriate attachments and the flaps on the anterior boxes closed to prevent the appliance coming out (*Fig. 4E*). Elastic traction is applied as indicated.

Although, in the case illustrated, the four anterior teeth have been banded, it is frequently only necessary to band the upper central incisors since apical movement is not required of the upper laterals. If, however, the lateral incisors are also banded, the pin to fit into this tube should be at a slightly higher level than that fitting into the central incisor brackets (*Figs. 3, 4*). The principle of lever torque used here is similar to that described by Clifford, but is, of course, applied in the opposite direction. This is not an easy appliance to use and it would be advisable to obtain experience with other simpler forms of the Watkin pin-and-tube before attempting it.

Fig. 5 shows superimposed radiographs of three treated cases. Superimposition of radiographs is notoriously misleading and *Fig. 5A* and *B* has therefore firstly been superimposed on the palatal outline and secondly on the line SN with N coincident. Although a rather different picture is given by the two superimpositions, there can be little doubt that some apical movement has occurred. The case shown in *Fig. 5A* has been out of retention for twelve months, but that shown in *Fig. 5B* is only now completing treatment. The case shown in *Fig. 5C* had a bilateral cleft of the palate and there can be little doubt that the great amount of movement shown involves some movement of the bony segment in addition to movement of the teeth through the bone. This case is being permanently retained following a bone-graft.

Acknowledgements

I wish to acknowledge the help given by numerous postgraduate students and Registrars of the Eastman Dental Hospital who co-operated with me in the treatment of the cases shown in *Fig. 5*. I would also thank Miss J. Jeffery for secretarial assistance.

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THE MEASUREMENT OF FORCES EXERTED BY ORTHODONTIC SPRINGS

H. LESTER, L.D.S. D.Orth. R.C.S.

ADJUSTMENTS to springs of orthodontic appliances are usually carried out arbitrarily, the clinical experience of the operator determining the amount of adjustment necessary; the actual force applied by the spring to the tooth is rarely measured in practice. Whilst in the majority of

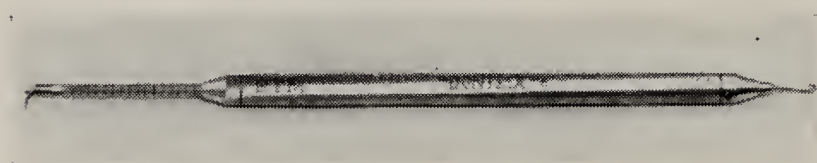


Fig. 1



Fig. 2

cases this procedure is satisfactory, there are occasions when it might be helpful to know how much force is being applied by the spring; for example, many operators have had experience of cases in which teeth in both quadrants of an arch are being moved, and the teeth on one side of the arch appear to be moving more rapidly than those on the other side.

The majority of authorities appear to be agreed that a pressure of 20–25 g. (1 oz.) per sq. cm. of root area is correct in the initial stages of tooth movement; at a later stage the force can be increased to 50–60 g. (Reitan, 1964; Storey and Smith, 1952).

MEASURING GAUGES

1. The Dontrix Richmond Stress and Tension Gauge (Fig. 1) consists of a Duralumin body and spring-loaded calibrated cylindrical shaft. At one end of the shaft a hook is attached; the other end is notched and also has a fork-like attachment. Two models are available, one measuring up to 16 oz., the other up to 4 oz. The gauge has been designed to measure orthodontic forces directly in the mouth. The forked end can be slipped over the archwire to measure the force of coil springs. The notched end is used to push against springs, and the hooked end can be used to measure the force of inter- and intramaxillary elastics.

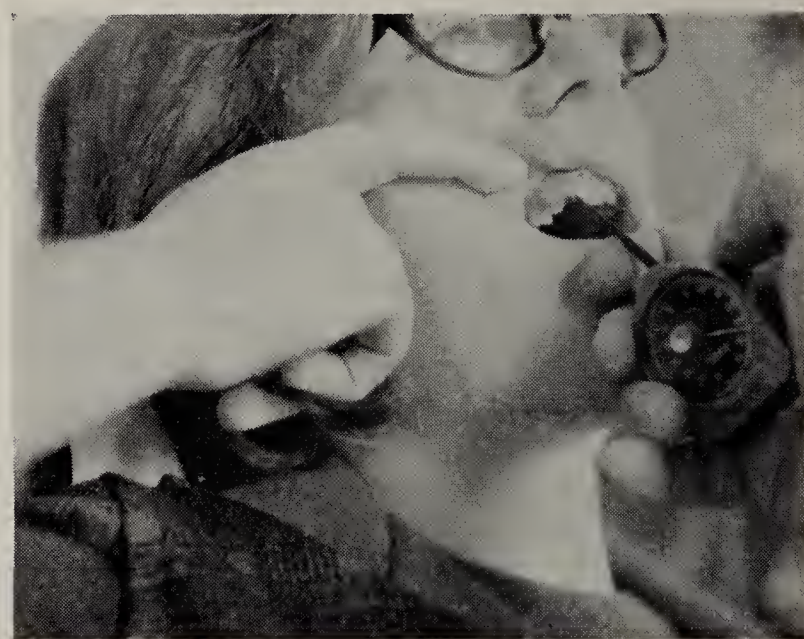


Fig. 3

2. The Halda Gram Gauge (Fig. 2) is an instrument used extensively in industry. It has a zinc alloy die-cast lacquered body with a steel pointer, and readings are taken from a circular dial, either clockwise or anticlockwise. The gauges are available in various versions to cover the desired measuring ranges, with an indicator on the dial to show the maximum reading reached, and either a flat point or ball point top to the gauge arm. The latter type with a small hook welded on to the arm end has been found most satisfactory in use, using the model with a measuring range of 15–150 g. The hook does not affect the accuracy of the gauge, but the hook

Demonstration given at the Country Meeting in Bristol on 14 April, 1967.

or point must be applied perpendicular to the force to be measured and this somewhat limits its use at the back of the mouth. The Halda gauge can be used to measure the force exerted by most types of orthodontic springs (*Fig. 3*) and also inter- and intramaxillary elastics.

Acknowledgements

I should like to thank Mr. R. W. Balcombe, of the Standards Section, Rolling Stock Development, Southern Region, British Railways, for introducing me to the Halda Gram Gauge,

Mr. W. H. Taylor of Halda Ltd., Brandon Road, London, N.7 for his help and for the loan of some gauges for this demonstration, also the E.T.M. Corporation, 144 W. Chestnut Avenue, Monrovia, California, for supplying *Fig. 1* and for permission to reproduce it.

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OCCLUSAL DISHARMONY IN UNTREATED AND TREATED PATIENTS WITH CLASS II, DIVISION 1 INCISOR RELATIONSHIP

R. H. BIRCH, M.D.S., F.D.S. R.C.S.

Lecturer in Preventive and Children's Dentistry, School of Dental Surgery, University of Liverpool

D. G. HUGGINS, B.D.S., F.D.S., D.Orth. R.C.S.

Consultant Orthodontist, Liverpool Dental Hospital

MANDIBULAR closure is dependent on the reflex co-ordination of temporomandibular muscles through afferent and efferent connexions with the central nervous system. Under ideal circumstances, centric relation and centric occlusion are coincident, but, as a result of orthodontic treatment, the pattern of occlusal contact is altered. Premature contacts may be produced during treatment, resulting in a disturbance in the pattern of muscle activity.

It was felt that this disturbance may be transient, in that after appliances were removed the occlusion is able to 'settle', and centric occlusion can be achieved again.

REVIEW OF THE LITERATURE

The effect of the muscular environment on the teeth and their occlusion has been widely discussed since Rix (1946) and Ballard and Gwynne-Evans (1947) published the result of their work.

Tulley (1953) was among the first in this country to use electromyography to investigate the activity of oral musculature. Pruzansky (1952), Møller (1958), and Timms and Greenfield (1961) dealt with the basic principles of electromyography. Moyers (1949, 1950) paid particular attention to the temporomandibular muscles and also discussed alteration in their electrical activity in Class II, division 1 incisor relationship cases before and after treatment. Perry (1955) compares electromyographically cases having Class II, division 1 incisor relation and those of excellent occlusion. Grossman, Greenfield, and Timms (1961) assessed alterations in muscle activity pattern before and after orthodontic surgical treatment. Grosfeld (1965) electromyographically investigated cases treated with Andresen appliances.

Recently, Marx (1963) had drawn attention to the use of integrators in electromyographic investigations.

The purpose of this cross-sectional study is the investigation of the effect of altered occlusal contacts on the pattern of electrical activity of the temporalis and masseter muscles.



Fig. 1.—Diagram illustrating the position of electrodes.

MATERIALS AND METHODS

The source of the material was a series of patients attending for the orthodontic treatment of Class II, division 1 incisor relationships. The age range was 11–14 years, there being male and female patients included.

Presented at the Country Meeting in Bristol on 15 April, 1967.

Patients in three phases of treatment were investigated:—

1. Pretreatment.
2. Completed treatment. Upper retaining appliance being worn.
3. Out of retention for a period greater than 6 months.

Treatment involved loss of teeth from either or both arches and use of removable and/or fixed appliances, over a period of 12 to 24 months. Retention with removable appliances was continued for a 6-month period, and record models were obtained to allow assessment of the occlusal pattern, together with lateral cephalograms to ascertain treatment progress.

The purpose of the occlusal movements described was to demonstrate premature contacts during the clenching phase, and this was followed by relaxation and swallow which induced the mandible to return to its rest position.

Electrodes

Surface electrodes were used for recording muscle activity. They consisted of $\frac{3}{8}$ -in. silver disks, concave on the fitting surface. Before positioning, the skin was cleaned with alcohol, and the electrode cups were filled with Cambridge electrode jelly and secured with adhesive tape, establishing a 3 cm. distance between each electrode. The electrodes were positioned in

Table I.—GROUP I: PRETREATMENT

<i>Electromyographic Findings</i>	<i>Occlusal Analysis</i>
3 cases with normal patterns	Balanced occlusal contacts (<i>Fig. 2</i>)
5 cases with unilateral high amplitude in temporalis or masseter pattern	With reduced number of contacts isolaterally (<i>Fig. 3</i>)
1 case with low amplitude of temporalis and high amplitude of masseter pattern	Balanced contacts
1 case with high amplitude of right masseter pattern	Increased contacts on right
1 case with low amplitude masseter and temporalis patterns	Light bilateral contacts
1 case with high amplitude of left temporalis pattern	Even contact (tipped $\overline{7}$)

Records of Muscle Activity

A Stanley Cox (5D) electromyograph was used to monitor muscle activity, and a Cossor oscillograph camera produced a permanent record on Ilford photographic paper at a film speed of 2.5 in. per second.

Recordings were made in a Faraday cage to minimize unwanted electrical interference.

The machine had two channels, which enabled bilateral recordings of one muscle to be made simultaneously.

Recording Technique

The patient was seated on a plain-backed chair with the head upright and unsupported in a relaxed state with the room darkened. Preliminary tests were carried out to familiarize patients with the movements required for the recording technique.

The aim of the investigation was to test the activity of the temporalis and masseter muscles, the former being responsible for general elevation of the mandible while the masseter is mainly concerned with final closure through the free-way space.

The patient carried out a rehearsed set of jaw movements, so that he clenched to occlude the teeth, relaxed, and then swallowed. This exercise was repeated three times for both temporalis and masseter recordings, and during this time, the results were recorded by camera.

such a manner as to record anterior (ventral) temporalis and masseter activity respectively.

The electrodes were related to the Frankfurt horizontal plane when recording temporalis and parallel to the mandibular plane for masseter activity (*Fig. 1*). A central forehead earth was attached.

Occlusal Analysis

Stone models were cast from alginate impressions. The patient was then rehearsed in occluding centrally, and Kerr's occlusal registration wax wafers were introduced between the occlusal surfaces, the contacts of which were registered through the wax. Points of heavy contact resulted in perforations of the wax which were transferred on to the stone models with carbon pencil.

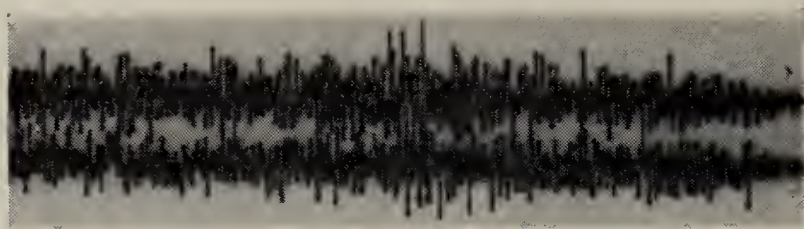
RESULTS

The total number of patients under investigation was twenty-one, arranged in three groups as follows:—

Group I: 12 pretreatment patients (6 male and 6 female).

Group II: 6 completed patients wearing retaining appliances (2 male and 4 female).

Group III: 3 patients out of retention for 6 months (2 male and 1 female).

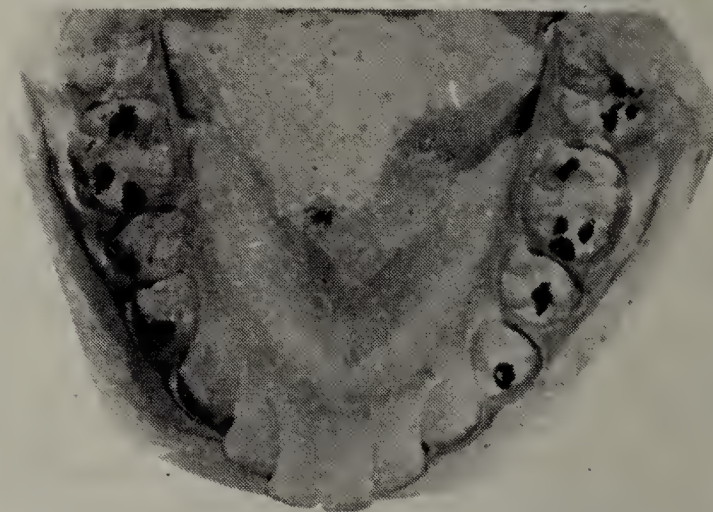


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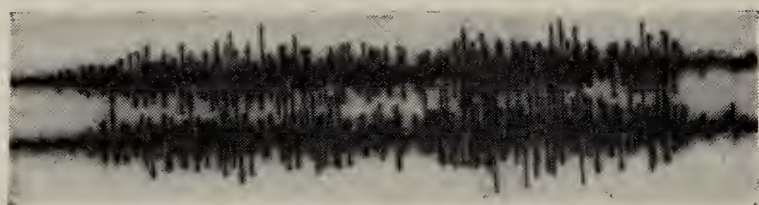
Fig. 2.—A, Shows normal electromyographic records of masseter. B, Normal temporalis recordings. C, Balanced occlusal contacts in the same case (J.W.).



C



A



B

Fig. 3.—A, Showing high amplitude of right masseter recording. B, Shows high amplitude for right temporalis recording. C, Photograph of models showing reduced number of contacts isolaterally on same case (D.K.).



C

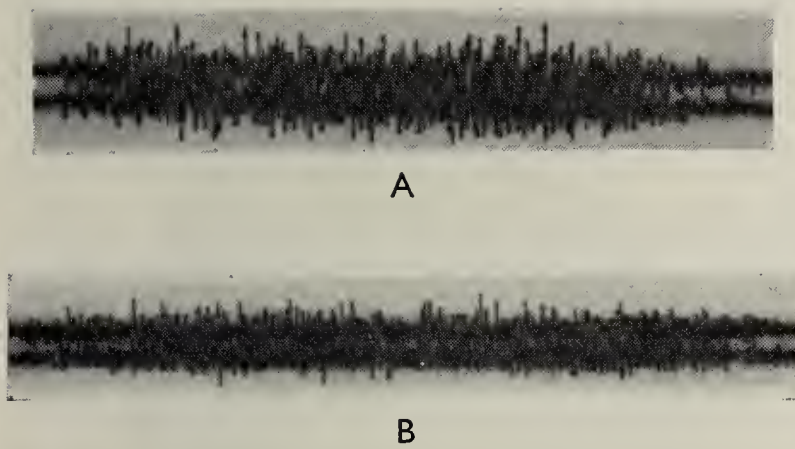


Fig. 4.—A, Showing normal electromyographic recording for masseter. B, Normal temporalis recordings. C, Showing models of same case with even contacts (M.H.).

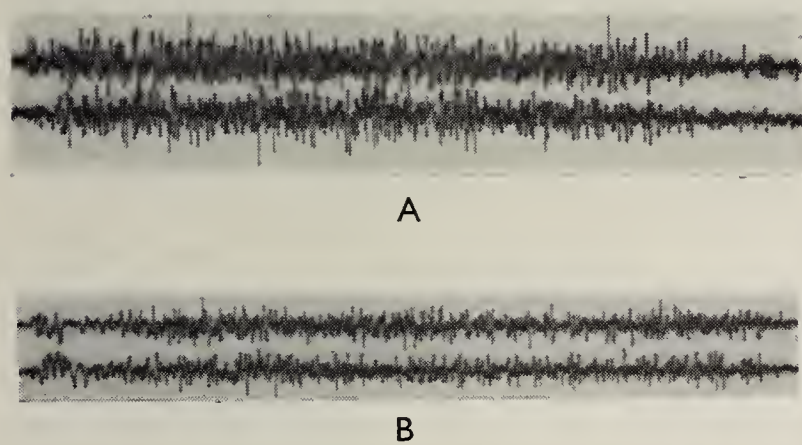
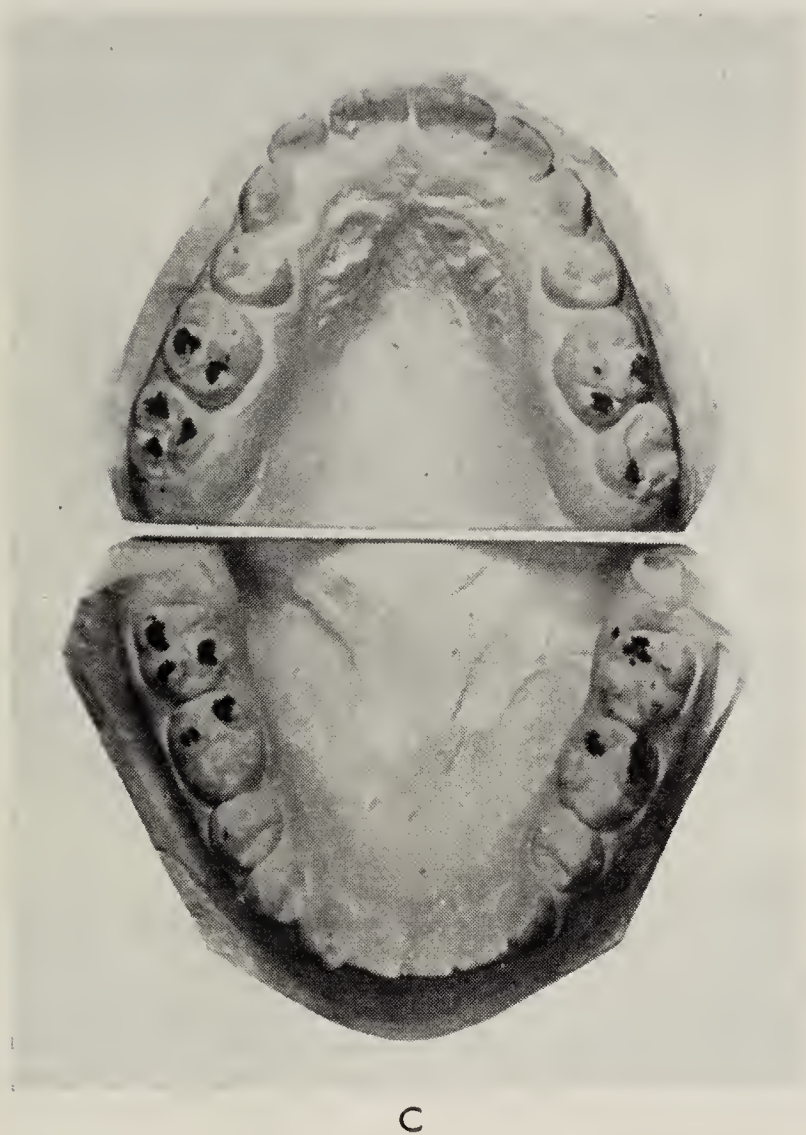
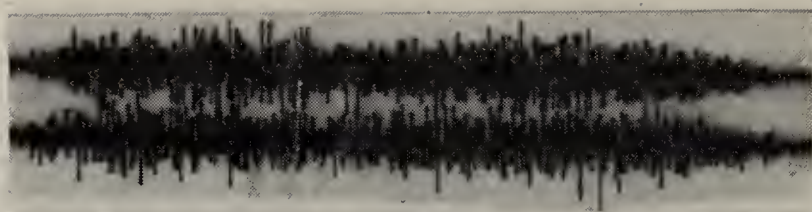
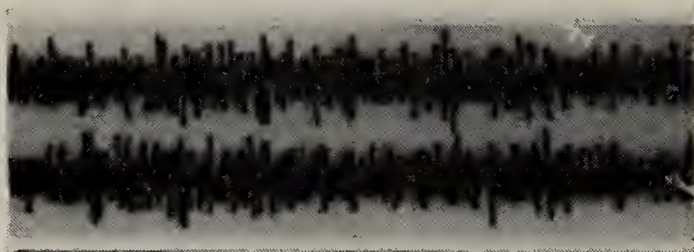


Fig. 5.—A, Demonstrates 'peaks and plateaux' in masseter recording. B, Shows similar features in temporalis recordings. C, Illustrates heavy right occlusal contacts (P.E.).





A



B

Fig. 6.—A, Shows normal masseter electromyographic recording. B, Shows normal temporalis electromyographic recording. C, Illustrating balanced occlusal contacts on the models of case shown in A and B (G.R.).



C

Discussion of Results

The findings of Timms and Greenfield (1961) indicated that disturbance of occlusion resulted in alteration in muscle pattern as shown on electromyographs. In this investigation approximately 75 per cent of cases in Group I showed irregularities of electromyographs. When the models of the Group I cases were analysed balanced occlusions were found in 50 per cent. The cases with balanced occlusions are equally distributed between those with normal and abnormal electromyographs. This substantiates

Group II: Completed Cases wearing Retainers

An interesting finding in the post-treatment (6 cases) was that approximately 82 per cent of cases showed normal electromyographic recording and also balanced occlusal contacts. With the

Table II.—GROUP II: COMPLETED PATIENTS WEARING RETAINING APPLIANCES

<i>Electromyographic Findings</i>	<i>Occlusal Analysis</i>
4 cases normal E.M.G.'s patterns	Even contacts (Fig. 4)
1 case searching pattern on right temporalis, E.M.G.	Heavy right occlusal contacts (Fig. 5)
1 case low amplitude, but balanced E.M.G.	No models

Table III.—GROUP III: PATIENTS OUT OF RETENTION

<i>Electromyographic Findings</i>	<i>Occlusal Analysis</i>
1 case normal E.M.G.	Balanced contacts (Fig. 6)
1 case low right amplitude temporalis and masseter. Jagged peaks and plateaux	2 contacts right. 4 contacts left. Cusp-to-cusp occlusion in molars and premolars
1 case high amplitude right—temporalis and masseter	3 contacts right. 4 contacts left

Moyers' (1949) findings when he claims that abnormal action potentials of one or other of temporomandibular muscles are found in Class II, division 1 cases. Moyers (1949) also found that there was a reduction in electromyograph amplitudes after treatment and this is corroborated by a case in the current investigations.

small number of cases involved, these results suggest that a longitudinal study could more accurately reflect the improvement achieved.

Group III: Out of Retention

The apparent benefits shown in the post-treatment groups were not reflected in the

limited number of cases investigated in this group, since only one case had normal electromyographs and balanced occlusion.

CONCLUSION

The results show that electromyographic irregularities are present before and after treatment and it was not possible in this study to correlate them in all cases with the occlusal patterns.

The investigation shows the paramount need for a longitudinal study through all stages and a more refined analysis of electromyographic results using integrators as suggested by Marx (1963).

Acknowledgements

The authors wish to thank Mr. J. S. Bailie of the Department of Dental Photography and colleagues in the United Liverpool hospitals for

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DISCUSSION

Mr. D. J. Timms said that electromyography, like fire, was a good servant but a bad master, and one must be absolutely sure of technique.

Surface electrodes were best, but phasic and directional errors arose from the use of bipolar electrodes and monopolar were probably better. Their positions were critical as different segments of the muscle served different functions in the directional sense, for example, anterior and posterior temporal and the superficial and deep masseters, so electrode positions should be accurately specified.

Coverage of the masticatory muscles could have been wider by subdividing the muscles and two channels were insufficient. Myograms were reflex patterns of co-ordination, therefore the wider the monitoring and the greater number of simultaneous recordings, the easier the interpretation. Whilst two channels might reveal imbalance in amplitude; the asynchronic imbalance, for example, early onset, was missed, but the biggest fault lay in the fact that the movements must be repeated for the different muscles, and one was left to assume that the movements were exactly the same in position and intensity for comparison of the myograms.

Three recordings might be insufficient as a check against aberrant behaviour; consistency over more and even on separate occasions would have been better, e.g., one week later. Also, one could have diametrically opposed recordings between temporalis and masseter.

The authors had not laid down any criteria for interpreting the myograms, but had divided them into balanced and imbalanced and had used normal and abnormal without correlation. He would not classify those with high or low amplitudes in both muscles as imbalanced—some people just bit harder or less hard than others—but this was done with the pretreatment group. Also, a case of high amplitude in one masseter and low amplitude in the opposing masseter was indicative of a deviated closure and not the numbers of contacts.

Criticism must be levelled at the method of selecting the subjects. The thesis lost most of its validity with so few cases by not following through the same patients in a longitudinal study—different patients before and after treatment did not make a realistic comparison; but this point was made in the paper.

He apologized if he had been unduly critical of the authors' methods after such painstaking work, but he agreed wholeheartedly with their conclusions concerning the presence of irregularities before and after treatment, the reason being that the behaviour of the muscles of mastication was a reflection of the maxillomandibular relationship at the basal level, whilst occlusion was a matter of intercuspitation. An ideal occlusion was neither a prerequisite nor a guarantee of normal maxillomandibular relationship.

Mr. R. H. Birch replied that with regard to the differences between the different muscles doing the same work, this was, of course, very true. This was a preliminary study and there was a new machine in Liverpool which they hoped to develop in this respect in their future trace recordings.

The imbalance in amplitude was largely the result of not having sufficient leads, and since they had to make some distinction bilaterally between the sets of muscles, amplitude was a factor they could look at, but, as Mr. Timms put it, the asynchronic imbalance could not be shown on the limited apparatus available to them.

With regard to the small number of patients, this was particularly felt as time went on, particularly in the group that were out of retention for over 6 months, for this, coupled with a longitudinal study, would have given much more positive emphasis to their findings, and a longitudinal study was absolutely essential for a large type of survey. This was a preliminary study and they had felt absolutely justified in employing the means used in this case.

Professor W. J. Tulley echoed what Mr. Timms said—that one could make the electromyograph do whatever one wanted—and the problems of getting a

piece of research of this kind into a really tidy form and producing statistical results could be extremely time-consuming, and at the end of it one was not quite sure.

Moyers, in his paper discussing pre- and post-treatment of Class II, because he found in the pre-treatment that the posterior temporals were more active than after treatment, deduced that there was a functional retrusion. They had long ago given up that idea in Class II, division 1 so that his whole paper may well have fallen to the ground had he done it a different way, and he wished, therefore, to issue this word of warning!

Dr. J. R. E. Mills, referring to the authors' comment that the cases were 6 months out of retention, asked whether they were deliberately recalled then or whether it was an average figure, and, if so, how wide was the range.

Mr. D. G. Huggins said that the patients were at least 6 months out of retention; some were 7 or 8 months. There were only three of them and it varied between 6 and 8 months. They tried to get them in at 6 months precisely. They perhaps came a week or a fortnight late.

Mr. R. Marx asked whether the authors found that there was an overall predominance of one side, irrespective of what they found on the models. Did they find, say, a right-sided predominance of muscle activity in the majority of cases they examined?

Mr. Huggins, in reply, said that speaking without counting the cases he would say no, they had not found a left- or right-handed predominance.

Mr. Birch thought the point might be worth following further when there were larger numbers. It had been said that a great majority of people were 'right-handed' in a number of their functions.

LOWER INCISOR CROWDING IN TREATED ANGLE CLASS II, DIVISION 1 OCCLUSIONS

B. H. MILLER, B.D.S. (Rand), F.D.S., D.Orth. R.C.S. (Eng.)

Senior Orthodontic Registrar, University College Hospital Dental School

IN 1936 Tweed published his philosophy relating the long axis of the lower incisor to the lower border of the mandible. He postulated that only when these teeth stood upright, over what he termed 'basal bone', could a stable end-result be expected.

This was the first attempt to use the lower incisor as a basis for the treatment of mal-occlusion, and there followed a flood of investigations into the behaviour of this tooth in both treated and untreated cases.

Schaeffer (1949) studied the axial inclination of the lower incisor in a series of untreated cases, largely between 8 and 18 years of age, and almost entirely Class I occlusions. He found the mean angle to the mandibular plane to remain fairly constant, though with wide individual variations. Whatever the change in axial inclination, the lower incisor always appeared to occupy a more posterior position in the symphysis at a later age.

Litowitz (1948) investigated 20 cases treated by nonextraction methods; 75 per cent of these were Class I occlusions, and the same percentage were treated by lower arch expansion to alleviate crowding. He found that where the axial inclination of the lower incisor had been increased, half the cases tended to return towards the original inclination, while half became more proclined. These changes were brought about by a combination of root and crown movement.

In more recent times, it has been realized that the axial inclination alone does not give a true indication of the position of the lower incisor crown in space.

Steiner (1959) related the lower incisor crown to a line from nasion to point B, and Ricketts (1964) to one from point A to pogonion. They both suggested what they considered should be the ideal distance to these 'planes'.

Mills (1964, 1966), has conducted two thorough investigations into lower incisor behaviour. The groups analysed were mixed with reference to Angle's classification. He estimated the antero-posterior position of the incisal edge by relating it in angular measurement to the sella-nasion plane.

The former study was to investigate the effect on the incisors of uncontrolled premolar extractions in the lower arch. The resultant 'lingual collapse' was found to be small and not clinically significant.

The latter study showed that proclination of the lower incisors was achieved by a combination of crown and root movement, and was followed by varying degrees of relapse. Forward movement at the incisal edge, however, was small compared with the change in axial inclination.

The problem of lower incisor crowding which develops as a later phenomenon in apparently successfully treated cases is still a real one, despite our greater knowledge of its behaviour.

It has been suggested that these changes are brought about by anterior and posterior components; the former by alteration of incisal position by natural growth changes, or as a result of treatment, and the latter by the eruptive force of lower wisdom teeth exerting a mesial pressure on the buccal segments.

MATERIAL

This investigation was carried out on 33 cases of treated Angle Class II, division 1 occlusions. All but 2 had a Skeletal II apical base relationship, and all were considered to be clinically stable results, as judged by reduction of overjet when final records were taken.

Eighteen of these cases were treated by inter-maxillary traction, in the form of a Norwegian plate, and 15 cases by extraction of upper premolars, with no lower arch treatment.

For the sake of convenience, those treated with Norwegian plates will be called N.P. cases, and where upper premolars were extracted, premolar cases.

METHOD

An assessment of lower incisor crowding was made by relating the six lower anterior teeth to each other, at all five contact points, and noting whether any alteration had occurred when final

models were taken. As will be seen on the diagram (Fig. 1) this can occur in a mesiodistal or buccolingual direction, or a combination of both.

Some cases before treatment showed no signs of crowding, or some spacing, while in others a degree of crowding was already present. Deterioration of incisor position was recorded, irrespective of the degree of severity of final

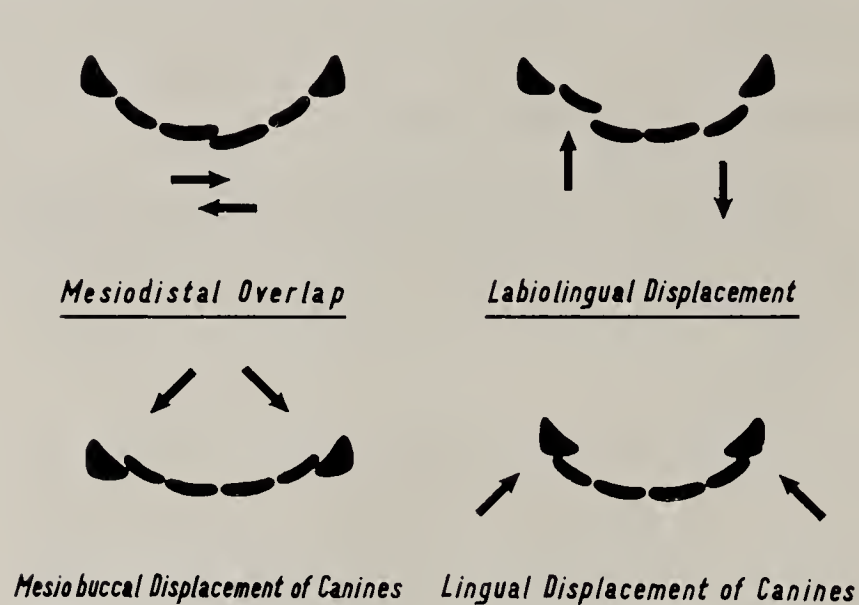


Fig. 1.—Assessment of lower incisor crowding.

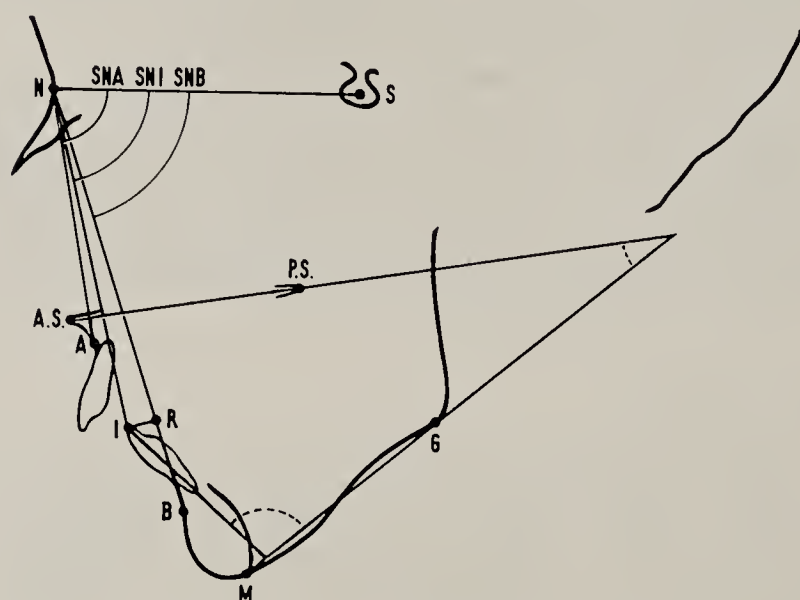


Fig. 3.—Cephalometric analysis.

Arch width was measured between the tips of the mesiolingual cusps of the first molars, and *arch length* from a line bisecting this at 90° to the incisal edge of the lower central incisors in the midline. Where crowding had resulted in displacement of one incisor, the tooth remaining in the line of the arch was used for measurement, and where this was not possible, both incisors were measured and an average taken.

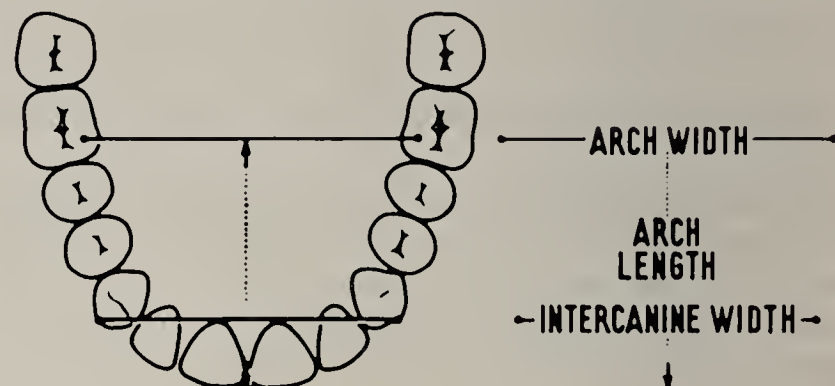


Fig. 2.—Determination of arch dimensions; measured in millimetres.

Where arch length had been altered by treatment, in the N.P. cases, changes were measured from the end of treatment to the time of taking final records.

Inter canine width was measured between the tips of the canines.

A double *cephalometric analysis* was made of lower incisor position (Fig. 3):—

- i. The long axis was related to the mandibular plane.
- ii. Using point I at the incisal edge as described by Mills (1964), the angle INB was employed to record the position of the crown in the antero-posterior dimension.

Angle INB was calculated from angles SNI and SNB, and indicated movement of point I in relation to growth at nasion and point B. This was reflected in linear measurement by a line from point I to point R, where this line makes an angle of 90° with NB.

Crowding of the lower incisors presented some difficulties as regards accuracy of tracing.

Table I.—ASSESSMENT OF TRACING ERROR

	\bar{I} MD PLANE	SNI	SNB	\bar{I} Mx PLANE	Mx—Md PLANE ANGLE
Mean difference	+0.09	+0.06	+0.19	+0.36	+0.19
Standard deviation	1.15	0.61	0.58	1.64	0.83
Standard error	0.22	0.11	0.11	0.32	0.16

crowding. Some of the milder changes were clinically quite acceptable.

Arch measurements were made with special measuring callipers, calibrated down to $\frac{1}{2}$ mm., readings being taken directly from the scale (Fig. 2).

Where doubt existed about incisor outline, a template was made from the clearest radiograph. Reference was also made to the study models, so that the same tooth was traced where alteration of incisor position had accompanied crowding.

Radiographs were taken before commencement of treatment, at the end of treatment, and at the end of varying periods out of retention.

To check the accuracy of tracing, one-third of the 99 radiographs were retraced on two occasions separated by an interval of approximately 2 months (*Table I*).

The mean difference, standard deviation, and standard error of the angles employed were

FINDINGS

Examination of changes in lower incisor position revealed that of the 18 cases treated with Norwegian plates, 10 developed crowding or increased crowding, while 11 of the 15 premolar cases showed this deterioration.

The age at first and final records, and the period out of retention, are shown in *Table II*.

Table II.—AGE-GROUPINGS AND PERIOD OUT OF RETENTION (IN YEARS)

	FIRST RECORDS		FINAL RECORDS		PERIOD OUT OF RETENTION	
	<i>Average Age</i>	<i>Age Range</i>	<i>Average Age</i>	<i>Age Range</i>	<i>Average Age</i>	<i>Age Range</i>
8 N.P. Cases (No Crowding)	10½	8-14	17	13½-20	2	1-4½
10 N.P. Cases (Crowding)	9½	8-11½	17	13½-23	2½	1-6
11 Premolar Cases (Crowding)	11¾	9½-13½	18	15-20½	4	1-8

Table III.—CHANGES IN AXIAL INCLINATION; N.P. CASES (NO CROWDING)

<i>1-Md Plane Angle°</i>		
(1-2)	(2-3)	(1-3)
+6	-2	+4
+3	-3½	-½
-3	-3½	-6½
-4	-1	-5
-4	-½	-4½
-2½	-1	-3½
-5	+3	-2
-2	+2	0

1=First records.
2=After treatment.
3=Final records.

Table IV.—CHANGES IN AXIAL INCLINATION; N.P. CASES (CROWDING)

<i>1-Md Plane Angle°</i>		
(1-2)	(2-3)	(1-3)
+5½	-2½	+3
+5½	-3	+2½
+5	-1½	+3½
+7	-1½	+5½
+3½	0	+3½
+7½	0	+7½
+5	+1½	+6½
+5	+3½	+8½
+2½	+2	+4½
-2	0	-2

1=First records.
2=After treatment.
3=Final records.

Table V.—CHANGES IN AXIAL INCLINATION; PREMOLAR EXTRACTION CASES (CROWDING)

<i>1-Md Plane Angle°</i>		
(1-2)	(2-3)	(1-3)
+1½	+3	+4½
+1½	-½	+1
+2½	-8½	-6
+1	-5	-4
+1	-3	-2
-1	-½	-1½
-½	-1	-1½
-3	-½	-3½
-½	-1	-1½
-½	-6	-6½
-4	0	-4

1=First records.
2=After treatment.
3=Final records.

It will be seen that treatment was started earlier in the N.P. cases than in the premolar cases.

The average age at which final records were taken did not differ much, although there were more N.P. cases in the younger age range.

The period out of retention for the premolar cases was approximately double that of the N.P. cases.

1-Md Plane Angle

Tables III-V show the change in axial inclination of the lower incisor. The numeral 1 indicates the position before treatment, 2 the position after treatment, and 3 the position at the time of final records.

N.P. Cases (No Crowding)

In the N.P. group, where no crowding developed, 6 cases showed a decreased inclination following treatment, while 2 increased (*Table III*). These latter 2 cases were associated with a

calculated. These demonstrated a reasonable degree of accuracy, being noticeably less where the upper incisor was related to the maxillary plane.

decrease of angle SNB, and a 'downward' growth pattern.

During the period out of retention the 2 cases where increase had occurred relapsed partially, while in the 6 cases where axial inclination had decreased, 4 continued to decrease while the remainder reversed their inclination.

The overall change revealed 7 out of the 8 cases showing no change or a decreased axial inclination.

N.P. Cases (Crowding)

In the N.P. cases with crowding, 9 out of 10 cases showed proclination following treatment (*Table IV*).

When out of retention 4 of these relapsed partially, 2 showed no change, and, in 3 cases, the axial inclination continued to increase.

The overall change showed 9 out of the 10 cases having an increased axial inclination.

Premolar Cases (Crowding)

Of the 11 premolar cases with crowding, 9 showed an overall decrease in axial inclination (*Table V*).

N.P. Cases (No Crowding)

In the N.P. group with no crowding, little change in arch dimensions occurred. In the 2 cases with decreased arch length, some spacing was present in the premolar regions.

N.P. Cases (Crowding)

Four of the N.P. crowding cases showed decreased arch length while 1 case of increased arch length was associated with extraction of second molars.

In all of the 10 cases the intercanine width had decreased.

Premolar Cases (Crowding)

Seven of the 11 premolar cases showed decreased arch length, while intercanine width decreased in 10 out of 11 cases.

All these changes were small ranging from $\frac{1}{2}$ to $1\frac{1}{2}$ mm., although with the method used for measuring arch length the actual change would theoretically be double that of the distance recorded.

The number of cases in which third molars were present is shown in the far right-hand

Table VI.—ANALYSIS OF ANGLE INB AND LINEAR MEASUREMENT IR

	<i>N.P. Cases</i> (No crowding)	<i>N.P. Cases</i> (Crowding)	<i>Premolar Cases</i>
Angle INB	+0.25°	+1.6°	0°
IR	+0.56 mm.	+2.2 mm.	+0.18 mm.

Table VII.—SHOWING NUMBER OF CASES WITH ALTERATION IN ARCH DIMENSIONS AND PRESENCE OF LOWER WISDOM TEETH

		<i>A.L.</i>	<i>A.W.</i>	<i>I.W.</i>	<i>Presence Third Molars</i>
8 N.P. Cases (No Crowding)	Increased	1	0	1	
	Decreased	2	1	0	7 (3 Imp)
10 N.P. Cases (Crowding)	Increased	1	1	0	
	Decreased	4	7	10	5 (2 Imp)
11 Premolar Cases (Crowding)	Increased	0	1	0	
	Decreased	7	6	10	10 (4 Imp)

Angle INB(°) and IR (mm.)

Table VI shows the group changes in angle INB and linear distance IR, from first to final records. The individual changes recorded were small, ranging from -1 to $+2\frac{1}{2}^\circ$ for angle INB, and -2 to $+4$ mm. for IR.

The N.P. cases with no crowding and the premolar group were similar, and showed little change. There was an increase for INB of 0.25° and 0° respectively, and 0.56 mm. and 0.18 mm. for IR.

The N.P. group where crowding occurred showed an increase of 1.6° and 2.2 mm.

These mean changes were compared by Student's 't' test, which indicated a highly significant difference between the N.P. group with crowding and the other 2 groups.

Changes in Arch Dimension

Changes in arch length, arch width, and intercanine width are shown in *Table VII*.

column, and, in brackets, the number impacted or potentially impacted.

Lower second molars were extracted in one case in each of the N.P. groups and in 3 cases in the premolar group.

DISCUSSION

N.P. Cases

Axial Inclination

Both cephalometric and clinical findings suggested significant differences between the 2 groups of cases treated with Norwegian plates. In the group where no crowding developed, most cases showed a decreased axial inclination following treatment, while the reverse applied in the other group.

It has been theorized that proclination of lower incisors followed by relapse to the original axial inclination is the cause of crowding in cases treated with Norwegian plates. This pattern of

change in axial inclination was seen in 4 out of the 10 cases where crowding occurred.

There was decrease in arch length in 2 of these 4, which suggested that in only 2 of an overall total of 18 N.P. cases would this theory be confirmed.

Angle INB(°) and IR(mm.)

Angle INB and linear distance IR suggested a more anterior position of the incisor crown in the N.P. group with crowding.

Arch Dimensions

Arch dimensions showed little change in the noncrowded group. The significant difference was the maintenance of intercanine width in these cases, while it decreased in every case where crowding occurred.

It would seem that the more anterior position of the incisor crown was unstable in relation to axial inclination over basal bone, and possibly soft tissue 'equilibrium'. The result was a decrease in arch dimensions, especially intercanine width, and crowding of the lower incisors.

The following are offered as possible explanations as to why crowding developed in some N.P. cases and not others:—

1. The difference in incisor position following treatment.

2. The non-crowded group tended to have less initial crowding.

3. Although variations existed, the mean retroclination of the upper incisors was 6.75° in this group, which compared with 12.25° where crowding occurred.

4. The efficiency of the appliance—this may have varied between the groups, regarding the 'capping' of the lower incisal edges.

Premolar Cases

Axial Inclination

In the premolar extraction group there was a significant tendency to retroclination of the lower incisors. This was associated with an average upper incisor retroclination of 12.5° .

This is somewhat in contrast to Björk and Palling's (1955) findings. In their study of adolescent age changes in untreated occlusions, they found a tendency towards compensatory forward inclination of the lower incisors in cases of maxillary overjet. Also, that the forward displacement of the lower arch, relative to the upper, was greater on average in these occlusions.

Angle INB(°) and IR(mm.)

Angle INB and linear measurement IR in the premolar group showed virtually no change. This was also reflected in individual cases.

Arch Dimensions

Changes in arch dimensions revealed a decrease in arch length, in arch width, and especially in intercanine width. Extraction of second molars

in 3 cases may well have influenced possible change in arch length.

In the 4 cases where premolars were extracted and *no crowding* occurred, 2 cases showed no change of axial inclination, and the remaining 2 increased by $2\frac{1}{2}^\circ$ and $4\frac{1}{2}^\circ$ respectively. In one case where the arch length decreased, there was a 'compensatory' increase in the other dimensions.

It is postulated that closure of upper residual spacing in the postretention period causes mesial movement of the lower buccal segments which encroach on the anterior teeth. This space closure was observed to a greater or lesser degree in every case. In 13 of the 15 cases, the upper cheek teeth moved mesially *in relation* to the lowers, rather than *with* them. In the other 2 cases where crowding occurred, the upper and lower teeth moved mesially together, but only unilaterally in each instance.

However, in a very large number of cases, despite closure of space by mesial movement of the upper teeth relative to the lower, the whole lower arch moved forward in relation to the upper, often accompanied by a reduction in overbite.

The contraction of the upper arch by the extraction of 2 units, in which the extent of upper incisor retraction may also be important, results in a Class I incisor relationship, which is maintained by the 'lip seal'.

This is not reflected in the apical base relationship and, therefore, not correlated with the growth pattern. As the mandible grows forward in relation to the maxilla, the lower incisor crowns are held by the palatal surfaces of the upper while the apices are carried forward.

It is suggested that the resulting retroclination of the lower incisors and concomitant decrease in arch dimensions, associated with forward movement of the buccal segments, are major factors in the development of crowding with this type of treatment.

Angles SNB and ANB

Angle SNB increased in all but 4 cases of all groups, while angle ANB decreased in 21 out of 29 cases.

Influence of Lower Wisdom Teeth

Regarding the existence of a posterior component namely lower wisdom teeth as an aetiological factor in the development of crowding, the following observations were made:—

N.P. Cases (No Crowding)

Lower wisdom teeth were present in 7 of the 8 N.P. cases without crowding. Although there was no significant decrease in arch dimensions, it is possible that crowding could occur later in 4 of the younger cases.

N.P. Cases (Crowding)

Five of the 10 N.P. cases with crowding had lower wisdom teeth present.

Of the 4 cases where decrease in arch length occurred, lower wisdom teeth were present in only 1, which suggested that the change in the other 3 cases was brought about by an anterior component.

Lower second molars were extracted in 2 cases in the N.P. groups. Arch length increased by $\frac{1}{2}$ mm. in both instances.

Premolar Cases

Lower third molars were present in 10 of the 11 premolar cases with crowding and in all 4 cases where no crowding occurred.

Decreased arch length occurred in 2 cases where the incisors were proclined, which suggested a causative factor posteriorly. Lower second molars, however, were extracted in 3 cases, one of which still showed decreased arch length. This suggested an anterior component.

In the remaining 5 cases, it was difficult to determine which component played a bigger role, although one would suspect changes anteriorly.

Of a total of 21 cases with crowding, only 3 suggested a direct relationship, and 5 a possible one, to the presence of third molars.

Their influence may well have emerged as a more important factor in a larger sample, but in this investigation did not appear to be as important as may have been expected. Nor did it appear to be significant whether or not they were impacted.

It also seemed clear that extraction of second molars will not have the desired effect, in face of antagonistic changes occurring anteriorly.

CONCLUSIONS

Although the number of cases investigated was small and no control group of untreated Class II cases was available, certain tendencies as illustrated by cephalometric and clinical changes were apparent.

The dimension and direction of mandibular growth relative to the maxilla is the basic factor

determining alteration of lower incisor position. Its importance is associated with the relationship of the lower to the upper incisor and, therefore, with the enveloping soft-tissue environment. Superimposed are the changes produced by orthodontic treatment which either aggravate or ameliorate the condition.

Ideally, a period of observation of growth pattern prior to commencement of orthodontic therapy would seem to be a very necessary adjunct in any approach towards the solution of this particular problem.

Dimensional changes in the cases investigated were small, but a combination of small changes in any one case would be sufficient to cause a severe degree of crowding.

No claim is made that every possible factor associated with the development of lower incisor crowding has been included. An attempt has been made, however, to demonstrate the actual changes occurring when related to the type of treatment carried out.

Acknowledgements

These are due to Dr. W. Grossmann and Mr. J. Moss for their very valuable criticism, and to Dr. W. Grossmann for permission to examine the cases which were treated in his department.

Thanks are due also to Mr. G. Rogers and Mr. V. K. Aster for their help in the preparation of slides and diagrams.

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DISCUSSION

Mr. M. A. Kettle said that this problem of lower incisor irregularity as an aftermath of treatment of Class II, division 1 malocclusion was one that concerned everyone, as a monobloc and the method of the extraction of upper premolars for the treatment of this condition were so commonly used. What one would really like to see emerging from this sort of work was something a little more positive as to eliminating some of the unknowns. There had been a series of figures of end-results of these cases, but he would have been very much happier to know a little more about the condition as it presented itself at the beginning. For instance, were the lips incompetent or potentially competent? This, obviously, was a very great factor because of the dynamic effect of the muscle movements on the arches and obviously

any change made must eventually become related to them. There was also the degree of overbite. Was there, in fact, a complete or incomplete overbite, because this was inevitably related to the irregularity of the lower incisor region.

Had Mr. Miller tried to keep some sort of control over the effect of the monobloc? Had he tried to keep the various factors as near equal as possible? Was the lower jaw postured forward a given amount, or opened a given amount? Also, the forward movement of lower incisors must be related to the control the plate exerted over them, and he wondered whether the cases that did allow some forward movement of the lower incisors were those which were not controlled by the acrylic overlapping the incisal edge.

Mr. Miller, in reply, agreed with *Mr. Kettle* that generalizations should not be drawn from wide groups, but felt that the tendencies as illustrated by the main groups showed some definite direction. Also, in a paper of this length, it was difficult to single out individual cases; things might have got out of hand. He agreed that it would have to be followed up on a more individual basis.

With regard to lip musculature, he had mentioned that the cases were carefully chosen on their final stability against overjet, in that there was no significant relapse or increase of overjet, so he felt that that may have eliminated the soft-tissue equilibrium to a certain extent.

He agreed that degree of overbite was probably very important with regard to the development of crowding. He had looked into this and in the N.P. group where crowding occurred there tended to be a slightly larger number of cases with a deeper overbite, but this also occurred in the other group and it did not seem to be an entirely significant factor.

As to the construction of the type of monobloc used, obviously these were not cases which were initially treated by himself, but with the method used in his particular department the bite was open to a fairly standard degree, and he would not have thought it would differ very much in that respect.

Capping of lower incisors was also very important and he mentioned this as being a possible factor. As the N.P. group where crowding occurred tended to have slightly more initial crowding than the other group, it was possible that in some of these cases the capping was cut away and the teeth were possibly proclined to a certain extent.

Mr. E. K. Breakspear said that he was very glad to notice that *Mr. Miller* tended on the whole to discount the effect of the posterior component, because for many years they had been led up a blind alley in concentrating too much on the position of the third molars.

He had had a case recently in which, four years ago, he would have thought it was quite a suitable one for considering the removal of the 7's in order to relieve impaction of the 8's; but as time went by the condition of the 8's improved by natural growth, and they came into very good occlusion. There was no trace at all of

lower incisor crowding, indicating that the whole thing had been carried out by natural growth.

In support of that he drew attention to one aspect of the figures. In the three groups shown in the last table, the proportion of impacted third molars was just about the same in all the three groups—3 out of 7, 2 out of 5, and 4 out of 10—and that again suggested to him that the presence or absence of impaction as such was not an important factor at all in this connection.

Dr. J. R. E. Mills said that for many years the orthodontic world had been more or less divided into two camps, depending on whether or not one believed that Norwegian plate appliances proclined lower incisors. Half said they did and half not. Had people been less emotional it would have been realized, as *Mr. Miller* had shown, that they did a little bit, but not very much, and in planning treatment this amount of proclination must be taken into account. In some cases they might be prepared to accept a little crowding.

Mr. Miller had apologized for not having a control group. It was practically impossible to have a control group of Class II, division 1 cases one did not treat, because it would be unethical, but from *Cryer's* work it seemed that some increase in crowding during the teens was a normal occurrence.

With regard to the extraction cases, it had to be remembered that where in one department patients were treated by two different methods they were probably not identical; subconsciously there was selection for extraction of upper premolar cases which were a little more crowded, and he wondered whether these were really to begin with rather more crowded. It was a terribly difficult thing to measure, but did *Mr. Miller* have the impression that the extraction cases were a little more crowded?

Mr. Miller, in reply, said that very few of them were selected originally by himself but he had looked into this factor and he would not have said that it varied very much in the lower incisor region. The selection was often made on whether crowding was present in the upper arch, and it was on this that the extraction of upper first premolars or the use of Norwegian plate was decided; but it was very difficult for him to say what criteria were used by someone who selected a case 8 or 10 years ago.

REPORTS OF MEETINGS

ORDINARY MEETING, 10 October

AN ORDINARY MEETING of the Society was held at Manson House, 26 Portland Place, London, W.1, on Monday, 10 October, 1966, at 6.30 p.m., with Mr. J. D. Hooper, President, in the Chair.

Apology for Absence

An apology for absence was received from Dr. W. Grossmann.

Minutes

The SECRETARY (Mr. Alan C. Campbell) read the Minutes of the Country Meeting in Eastbourne. These were confirmed and signed as a correct record.

Candidates for Election

The following candidates for Ordinary Membership were elected *en bloc* by show of hands:—

Mr. D. Barker, L.R.C.P.(Lond.), M.R.C.S.(Eng.), L.D.S.(U. Leeds), D.Orth. R.C.S.(Eng.), Wain Cottage, Love Lane, Eastbourne, Sussex.

Mr. N. Bass, B.D.S., L.D.S.(U. Manc.), F.D.S., D.Orth. R.C.S.(Eng.), 44 Harley Street, London, W.1.

Mr. J. J. Crabb, B.D.S.(U. Birm.), L.D.S. R.C.S.(Eng.), 10 Highfield Drive, Sutton Coldfield, Warwickshire.

Mr. D. G. Greenfield, L.D.S. R.C.S.(Eng.), Millbush Farm, East Orchard, Shaftesbury, Dorset.

Mr. E. Mizrahi, B.D.S.(U. Wits.), 10 Forest Drive, Timperley, Cheshire.

The PRESIDENT welcomed any visitors who might be present, and said that he hoped they would enjoy their evening. He then delivered his Presidential Address entitled, '*Orthodontics as a Public Service: The Wessex Survey*'.

A vote of thanks to the President for his Address was proposed by Mr. G. C. Dickson and carried with acclamation.

ORDINARY MEETING, 14 November

AN ORDINARY MEETING of the Society was held at Manson House, 26 Portland Place, London, W.1, on Monday, 14 November, 1966, at 6.30 p.m., with Mr. J. D. Hooper, President, in the Chair.

Apologies for Absence

The SECRETARY reported that apologies for absence had been received from Mr. R. E. Rix and Mr. G. H. Roberts.

Minutes

The Minutes of the meeting held on Monday, 10 October, 1966, were read by the Secretary, confirmed, and signed as a correct record.

Introduction of Members

Mr. N. Bass, a member whose election had been confirmed at a previous meeting, was introduced to the President.

Candidates for Election

Honorary Membership

The following members were elected to Honorary Membership of the Society:—

Professor M. A. Rushton, C.B.E., M.D.(U. Cantab.), F.R.C.S.(Eng.), F.D.S. R.C.S.(Eng.), F.D.S. R.C.S.(Edin.), 'Alcala', Kippington Lane, Sevenoaks, Kent.

Mr. B. R. Townend, O.B.E., F.D.S., D.Orth. R.C.S.(Eng.), 'Two Cottages,' 8/9 West Street, Hambledon, Portsmouth, Hants.

Ordinary Membership

The following candidates were elected:—

Mr. M. M. Silver, L.D.S. R.C.S.(Eng.), 27 St. John's Grove, London, N.19.

Mr. M. C. Eagland, B.Ch.D., L.D.S.(U. Leeds), Turner Dental School, Bridgeford Street, Manchester, 15.

Corresponding Membership

The following candidates were elected:—

Dr. Max Schleimer, D.D.S.(N.Y.), 5828 N. Adenmoor Avenue, Lakewood, California, U.S.A.

Dr. L. J. Pinsker, D.D.S.(Temple U.), 5828 N. Adenmoor Avenue, Lakewood, California, U.S.A.

The PRESIDENT welcomed any visitors who might be present and hoped that they would consider themselves as members for the evening and would take part in any discussion.

He then introduced Mr. J. H. Gardiner, who presented his paper entitled, '*Midline Spaces*'.

ORDINARY MEETING, 12 December

AN ORDINARY MEETING of the Society was held at Manson House, 26 Portland Place, London, W.1, on Monday, 12 December, 1966, at 6.30 p.m., with Mr. J. D. Hooper, President, in the Chair.

Apologies for Absence

The SECRETARY reported that apologies for absence had been received from Drs. W. Grossmann and W. Russell Logan and Mr. and Mrs. Robertson-Ritchie.

Minutes

The Minutes of the meeting held on Monday, 14 November, 1966, were read by the Secretary, confirmed, and signed as a correct record.

The PRESIDENT welcomed any visitors who might be present, and called upon Mr. R. D. Howard to read his paper, '*The Unerupted Incisor*'.

Following discussion of Mr. Howard's paper, the PRESIDENT asked Mr. G. A. James to present his paper entitled, '*Clinical Implications of a Follow-up Study after Fraenectomy*'.

ORDINARY MEETING, 9 January

AN ORDINARY MEETING of the Society was held at Manson House, 26 Portland Place, London, W.1, on Monday, 9 January, 1967, at 6.30 p.m., with Mr. J. D. Hooper, President, in the Chair.

The PRESIDENT welcomed members to the first meeting of 1967 and wished them all a happy New Year.

Minutes

The SECRETARY read the Minutes of the meeting held on Monday, 12 December, 1966. These were confirmed and signed as a correct record.

Candidates for Election

The following candidates were elected *en bloc* by show of hands:—

Ordinary Membership

Mr. W. P. L. Bell, B.D.S.(Otago), D.Orth. R.C.S.(Eng.), D.D.O. R.C.P.S.(Glasgow), 10 Byron Court, 26 Mecklenburgh Square, London, W.C.1.

Mr. R. S. Bodenham, B.D.S.(Durham), F.D.S., D.Orth. R.C.S.(Eng.), The Dental Hospital, St. Mary's Row, Birmingham 4.

Mr. F. J. Hughes, B.D.S.(Glasg.), H.D.S., D.D.O. R.C.P.S.(Glasg.), F.D.S. R.C.S.(Edin.), 3 Windsor Crescent, Elderslie, Renfrewshire.

Mr. V. J. Patel, B.D.S.(Bombay), L.D.S. R.C.S.(Eng.), D.D.O. R.C.S.(Glasg.), 187 Cathedral Road, Cardiff.

T. Lam Yat-wah, L.D.S.(Vict.), B.D.Sc.(Melb.), D.Orth. R.C.S.(Eng.), F.D.S. R.C.S.(Edin.), 35 Arthur Road, London, N.7.

Mrs. P. M. Tanner, L.D.S. R.C.S.(Eng.), Quantock, 21 Meadway, Berkhamsted, Herts.

Corresponding Membership

Mr. Stelios Bakatselos, B.D.S.(Athens), D.D.O. R.C.P.S.(Glasg.), 79 Egnatia Street, Thessalonika, Greece.

The PRESIDENT declared these members duly elected.

After welcoming visitors, he called on Mr. D. B. Johnson to present his paper entitled, '*Some Observations on Certain Developmental Dento-alveolar Anomalies and Stigmata of Cleft*'.

After which Mr. John Metcalf read his paper entitled, '*Class II Treatments—Two Case Reports*'.

ORDINARY MEETING, 13 February

AN ORDINARY MEETING of the Society was held at Manson House, 26 Portland Place, W.1, on Monday, 13 February, 1967, at 6.30 p.m., with Mr. J. D. Hooper, President, in the Chair.

Apologies for Absence

The SECRETARY reported that apologies for absence had been received from Messrs. Walpole Day, Campbell, and D. Robertson-Ritchie.

Minutes

The SECRETARY (Mr. A. C. Campbell) read the Minutes of the meeting held on 9 January, 1967, and these were signed as a correct record.

Introduction of Members

The following members, whose election had been confirmed at a previous meeting, were introduced: Mr. R. S. Bodenham, Mr. J. J. Crabb, Mr. M. C. Eagland, Mrs. P. M. Tanner, and Mr. E. Mizrahi.

Candidates for Election

Life Membership

The PRESIDENT announced that in accordance with Bye-law 9, the Council had approved nomination by Messrs. J. S. Beresford, C. L. Endicott, J. S. Rose, and P. T. Heffer of Mr. G. Scott Page, 65 Mount Ephraim, Tunbridge Wells, Kent, for Life Membership of the Society.

Mr. Scott Page was duly elected.

Mr. Scott Page thanked the Council and members for electing him to Life Membership of the Society.

Ordinary Membership

The following candidates were elected *en bloc* by show of hands:—

Professor D. C. Berry, Ph.D., M.D.S.(U. Bristol), The Dental Hospital, Lower Maudlin Street, Bristol 1.

Mr. C. J. R. Kettler, B.D.S.(U. Lond.), L.D.S., D.Orth. R.C.S.(Eng.), 72 Hill Road, Portchester, Fareham, Hants.

Mr. D. B. Lawton, B.D.S.(U. Lond.), L.D.S. R.C.S.(Eng.), 'The Flat', 138 London Road, Sevenoaks, Kent.

Mr. S. I. M. Robinson, F.D.S., D.Orth. R.C.S. (Eng.), 7 Devonshire House, 4 Devonshire Avenue, Sutton, Surrey.

The PRESIDENT welcomed any visitors who might be present.

He then referred to the item on the Agenda paper stating, 'Attention is drawn to Bye-law 19 whereby nominations for Council Office for 1967/68 may be made by four properly qualified Members if received in writing by the Secretary at least seven days prior to the Ordinary Meeting in March, 1967', and pointed out that it was perfectly in order for people to nominate for Council office but nominations must be received by this particular date.

He then introduced Mr. B. S. Cryer and asked him to read his Chapman Prize Essay entitled, '*Third Molar Eruption and the Effect of Extraction of Adjacent Teeth*'.

Following the paper and its discussion, the President presented the Chapman Prize to Mr. Cryer.

ORDINARY MEETING, 13 March

AN ORDINARY MEETING of the Society was held at Manson House, 26 Portland Place, London, W.1, on Monday, 13 March, 1967, at 6.30 p.m., with Mr. J. D. Hooper, President, in the Chair.

The PRESIDENT said that, before commencing the meeting, he had to inform members that, since the last meeting, a member, whom they all knew and remembered very well, Mr. Norman Gray, had died in Eastbourne.

Members stood for a moment in silent tribute.

Minutes

The Minutes of the meeting held on 13 February, 1967, were read by the SECRETARY (Mr. Alan C. Campbell) and signed as a correct record.

Introduction of Members

The following members were introduced to the President and signed the Obligation Book: Mr. F. L. Coker, Mr. C. J. R. Kettler, Mr. S. I. M. Robinson, and Mr. W. P. L. Bell.

Candidates for Election

The following were elected to Ordinary Membership *en bloc* by show of hands:—

Mr. S. Johnson, B.D.S.(U. Durham), D.D.O. R.C.P.S.(Glasg.), Flat 1, 24 Pembridge Square, London, W.2.

Mr. C. Ratcliffe, B.D.S.(U. Lond.), L.D.S. R.C.S.(Eng.), 120 Green Lane, Bolton, Lancs.

Mr. B. Scheer, B.D.S.(U. Lond.), L.D.S. R.C.S.(Eng.), 66 Corringham Road, London, N.W.11.

The PRESIDENT welcomed visitors. He then announced that a meeting of the Society would be held in Scotland, at the Royal College of Physicians and Surgeons of Glasgow, on 27 October, 1967.

He then asked Mr. P. I. Townend to read a Short Communication entitled '*Resorption of the Roots of Upper Incisor Teeth due to Misplaced Canine Teeth*'.

Following the discussion of Mr. Townend's communication, Mr. T. P. Bass read a paper entitled, '*Observations on the Misplaced Upper Canine Tooth*'.

RESEARCH MEETING, 13 April

THE RESEARCH MEETING of the Society was held in the Queen's Building, the University of Bristol, on Thursday, 13 April, 1967. The PRESIDENT, Mr. J. D. Hooper, occupied the Chair and papers and research reports were presented as follows:—

2.15 p.m. Research Report Session:—

Mr. J. D. Atherton: '*Cleft Palate in the Dog*'.

Mr. W. J. B. Houston: '*A Cephalometric Analysis of Angle Class II, Division 2 Malocclusion in the Mixed Dentition*'.

Dr. Olli Rönning and Professor Kalevi Koski: '*Observations on the Histology and Histochemistry of Growth Cartilages in Young Rats*'.

Dr. N. R. Thomas: '*Observations on Tooth Eruption*'.

Dr. T. H. M. Wynne: '*The Cranial Base of the Developing Human Foetus*'.

ANNUAL GENERAL MEETING, 14 April

THE ANNUAL GENERAL MEETING of the Society was held in the Large Engineering Lecture Theatre, Queen's Building, University of Bristol, on Friday, 14 April, 1967, at 9 a.m., with the PRESIDENT, Mr. J. D. Hooper in the Chair.

Apologies for Absence

The SECRETARY reported that apologies for absence had been received from Mr. Rix, Mr. Robertson, Mr. Pilbeam, Mr. and Mrs. Robertson-Ritchie, Mr. R. A. Campbell, Mrs. Schouker, and Mr. Silver.

Minutes

The Minutes of the Annual General Meeting held at Eastbourne on 20 May, 1966, were read by the SECRETARY and signed by the PRESIDENT as a correct record.

Election of Officers and Councillors

The PRESIDENT said that the Agenda set out the nominations which had been put forward by the Council. There had been no other nominations.

In view of this it seemed that the simplest course would be to elect them *en bloc*, if members were agreeable to this course. (Agreed.)

He therefore proposed that the Officers and Councillors, as set out in the Agenda, be elected for the following year:—

<i>President:</i>	Mr. J. S. Beresford
<i>Immediate Past President:</i>	Mr. J. D. Hooper
<i>President Elect:</i>	Mr. T. Jason Wood
<i>Senior Vice-President:</i>	Prof. D. P. Walther
<i>Vice-President:</i>	Mr. J. H. Gardiner
<i>Councillors:</i>	Mr. C. P. Adams Mr. T. D. Foster Mr. W. Frankland Dr. W. Grossmann Mr. R. W. Willcocks
<i>Treasurer:</i>	Mr. J. S. Rose
<i>Secretary:</i>	Mr. A. C. Campbell
<i>Assistant Secretary:</i>	Mr. C. P. Briggs
<i>Editor:</i>	Dr. J. R. E. Mills
<i>Curator:</i>	Mr. B. C. Leighton
<i>Librarian:</i>	Miss J. G. Ritchie

The proposal was carried.

Election of Two Auditors

Mr. C. P. Briggs proposed that Mr. P. H. Burke and Mr. J. F. Pilbeam be invited to continue as Auditors.

Miss J. G. Ritchie seconded.

There were no other nominations and the proposal was carried.

Hon. Treasurer's Report

As the Financial Year of the Society now ended on 31 December, the current accounts covered a period of fifteen months, so strict comparison with the results of previous years would be somewhat misleading. Nevertheless, the general trend showed that the expenditure of the Society was still greater than its income. In fact, in the period covered by the accounts, there was an excess of expenditure over income of near £152, in spite of an increase of £230 in the Society's income. Just over half the latter figure was accounted for by the change in the Society's investments, the income from which that year amounted to some £460. However, this was unlikely to be quite so high next year because fifteen months' receipts were included, and because some extra dividends were paid during this year for corporation tax reasons. He was once again grateful to the Librarian for her efforts in the sale of the *TRANSACTIONS* of the Society.

Practically all costs had continued to rise and, in the period represented in the accounts, expenditure was £315 more than the last year. He could see no possibility of these costs decreasing without reducing the services of the Society. Thus, on another item of the Agenda, members would have noted the proposal to increase their subscriptions.

The adoption of the report was proposed from the Chair and carried.

Hon. Secretary's Report

During this year—the first to run from one Country Meeting to another—six Ordinary Meetings had been held with an average attendance just short of 100, which compared quite favourable with meetings held at the previous time of 7.30 p.m. This figure, of course, was taken from the signatures in the attendance book, and it had been clear on a number of occasions that some members had not signified their presence in this way. Might he remind members how helpful it was to have numbers recorded fully so that adequate services might be provided subsequently?

The membership continued to grow and was expected to be 596 at the end of that month. Numbers had been depleted by two deaths—one an Honorary Member, Mr. Norman Gray—and 12 resignations, together with 5 memberships which had lapsed under Bye-law 15. They had been joined by 27 new members—24 Ordinary and 3 Corresponding.

At the conclusion of this meeting the Society should have 6 Honorary Members and 7 Life Members.

Some change or rearrangement of the Society's accommodation had been envisaged for some years. This thorny problem had been most carefully considered this year, particularly in relation to the Society's financial position. New accommodation which had so far been considered seemed to offer Members little advantage as far as meetings were concerned.

In response to suggestions received from Members in Scotland, the Council had agreed to foster and support an Extraordinary Meeting in the next season's programme. As Members would have seen from their agendas this would be held in Glasgow on 27 October next, when the new President would participate in the meeting. He was sure that this innovation would strengthen the Society and its relationship with Members residing at a distance from London.

He would like to complete his report by reminding Members that the Council was anxious to hear of, and receive, offers of material for inclusion in the future programme. He begged to move the reception of this report.

The report was adopted.

Hon. Editor's Report

This Country Meeting brought to an end the first full year which the Society had held under the new calendar and he should perhaps say something about the arrangements for publishing the *TRANSACTIONS*. The 1965 *TRANSACTIONS* were sent to members some months ago. The 1966 volume would cover the period from January of that year to the end of the Country Meeting

in Eastbourne. These were now with the binders and members should receive them during the summer. The next volume would be dated 1966-67 and would cover the year from October 1966 to April 1967.

Otherwise he had little to report. The TRANSACTIONS had continued to be published in the *Dental Practitioner* and the Editorial Committee had continued its duties in arranging the scientific programme. They were always glad to consider offers of paper and short communications from members. Furthermore, if members could suggest speakers who might be invited to address the Society, such suggestions were always very welcome.

The report was adopted.

Hon. Librarian's Report

During the past year the main activity had been the sale of past and present TRANSACTIONS of the Society. This had so severely depleted stocks that there were now no past TRANSACTIONS for sale from the years 1921-1949, inclusive, also 1958, 1959, 1961, and 1962. As there was frequently a request for some of these early TRANSACTIONS, a gift to the Society of these old TRANSACTIONS would be greatly appreciated. The cost of new TRANSACTIONS on sale to non-members had been raised to three pounds.

As the future of the Museum and Library was being investigated by the Council and as the overcrowding of the Library was now acute, no new books had been acquired. Members were reminded, however, that the Library had complete sets of past TRANSACTIONS from 1908-1965. In addition, there were periodicals such as the *American Journal of Orthodontics*, the *Angle Orthodontist*, *Dental Abstracts*, and the *Dental Practitioner*. These were mainly monthly publications and were available for loan to members.

The report was adopted.

Hon. Curator's Report

He was glad to report the donation of models, X-rays, and specimens of a case showing supernumerary molars by Mrs. Carvalho.

Apart from this there was very little to report on the Museum since the last Annual General Meeting. For this reason it seemed appropriate to present to members an account of the stock in the Museum and some of its deficiencies.

The Museum itself had two objectives: first to be a repository for articles of historical interest, and secondly, to store a bank of clinical material which could be of great value to those who were studying or were undertaking research. This might of course in time come to support the first objective.

Of the first type there was depressingly little. Most precious possessions of all were the Minute books of both General and Council meetings since the Society was founded. Thanks to the

zeal of previous curators, there was also an Album containing photographs of every President since J. H. Badcock. A series of face masks of his son taken by Dr. Northcroft was also of particular interest. There were, however, hardly any appliances.

The clinical part of the Museum was divided into four main sections:—

- a. Serial models.
- b. Examples of anatomically correct occlusion.
- c. A morphological classification of the variations and modifications of the teeth in man.
- d. Malformations associated with endocrine dysfunctions.

The first of these was perhaps of the greatest value to members and was well worth extending. At present it contained 16 series, most of which, however, covered only part of the developing period. If any members had series available from birth to adulthood, duplicates of these would be most welcome, particularly where they depicted the development of normal occlusion. If these were to be supplemented by cephalometric, or even photographic, records, they would be especially valuable. The Curator would be glad to arrange for these to be reproduced as 2 in. × 2 in. slides. Similarly, there were only a few examples of anatomically correct occlusions; these were displayed at the last Country Meeting.

The third section contained examples of irregularity and malocclusion divided according to a classification suggested by Dr. Northcroft to this Society in 1935. Although some sections were quite well stocked, others were almost empty. Many of the specimens were rather bizarre examples, obviously included because of their unusual nature, and their quality was not always of a high order. In particular, the radiographs were poor, and did not resist the ravages of time.

The last section, 'Malformations associated with endocrine dysfunctions', contained no specimens at all. He would like to suggest that its title be altered to, 'Congenital malformations of the face and jaws'. This could be a particularly interesting subject, and might include both descriptive specimens and serial records of treated cases.

He had prepared a list of the items of which the Museum is deficient and had placed it on display to members with the demonstration of Museum specimens of extra teeth.

The report was adopted.

Bye-Law 13

The TREASURER then proposed, and Mr. B. C. Leighton seconded, an amendment of the Society's Bye-Law 13 so that from 1 January, 1968, the Annual Subscription should be £5 for Ordinary Members and that for Corresponding Members £3. The subscription for a Member joining within three years of obtaining a

registrable dental qualification should remain unaltered.

Messrs. J. S. Beresford and J. H. Gardiner spoke in support of the motion which was carried unanimously.

Any Other Business

Mr. F. Allan complained that the Council was dominated by practitioners who did not belong to the General Dental Service, and that insufficient attention was given to the requirements of such practitioners. He had proposed at the previous Annual General Meeting that the constitution of the Council should be altered.

Mr. T. D. Foster pointed out that if the membership as a whole was dissatisfied with the Council, it had it in its power to replace it.

Mr. Allan disagreed.

Mr. PRESIDENT said that Mr. Allan had aired his views. There did not seem to be a great deal of support for them, but no doubt Mr. Allan would continue to press his point.

There being no other business, the President declared the meeting closed.

COUNTRY MEETING, 14 and 15 April

THE TENTH COUNTRY MEETING opened in the Large Engineering Lecture Theatre, Queen's Building, University of Bristol, at 10 a.m., with the President, Mr. J. D. Hooper, in the Chair.

The PRESIDENT welcomed all those taking part in the Meeting, and expressed the hope that there would be a full participation in the discussions on the various papers.

Minutes

The SECRETARY read the Minutes of the March Ordinary Meeting. These were confirmed and signed as a correct record.

Candidates for Election

Honorary Membership

The PRESIDENT said that it was their great pleasure to suggest to the Society that a very old and distinguished member, Mr. R. E. Rix, should be elected to Honorary Membership. Mr. Rix joined the Society in 1929, but apart from length of service, it would be agreed by everyone that his contributions to the Society had been very distinguished. He was, unfortunately, not able to be present to-day.

He therefore moved that, 'Mr. R. E. Rix be elected to Honorary Membership'.

The motion was carried by acclamation.

Ordinary Membership

The SECRETARY read out the names of the candidates for election to Ordinary Membership:—

Mr. P. C. S. Campion, L.D.S. R.C.S.(Eng.), 61 Wimpole Street, London, W.1.

Mr. E. Greene, B.D.S.(N.U. Irel.), 21 Lower Baggot Street, Dublin 2.

Mr. W. D. MacCallum, B.D.S.(U. Glasg.), 48 Westbourne Crescent, Bearsden, Glasgow.

Mr. J. K. Williams, B.D.S.(U. Lond.), F.D.S., D.Orth. R.C.S.(Eng.), 38b Brondesbury Road, London, N.W.6.

The PRESIDENT asked whether it was the wish of the meeting to elect *en bloc* and by show of hands. This was agreed.

After a show of hands, the President declared the candidates to be duly elected to the Society.

The Scientific Programme was then presented as follows:—

Friday, 14 April

10.00 a.m. 21st Northcroft Memorial Lecture: Professor C. F. Ballard: '*The Morphological Basis of Prognosis Determination and Treatment Planning*'.

11.15 a.m. Coffee.

11.45 a.m. Paper: Mr. M. S. Berman and Mr. N. Upson: '*A Method of Producing Bodily Movement of Incisor Teeth*'.

12.30 p.m. Lunch in the University Refectory.

2.00 p.m. Case Report: Mr. D. Munns: '*A Case of Partial Anodontia and Supernumerary Tooth Present in the Same Jaw*'.

2.20 p.m. Short Paper: Mr. D. F. Glass: '*Intra-oral Burns*'.

2.40 p.m. Case Report: Mr. D. I. Smith: '*Cleft Lip and Palate in One of Monozygotic Twins*'.

3.00 p.m. Tea.

3.30 p.m. Table Demonstrations.

8.00 p.m. Annual Dinner at the Mayfair Suite, New Bristol Centre, Frogmore Street, Bristol.

Table Demonstrations:—

Mr. F. Allan: '*Some Orthodontic Cases of Special Interest*'.

Mr. J. H. Gardiner: '*The Fairchild Mark IV Cine Viewer in the Demonstration of Orthodontic Technique*'.

Mr. H. Lester: '*The Measurement of Forces exerted by Orthodontic Springs*'.

Dr. J. R. E. Mills: '*Modification of Standard Orthodontic Appliances*'.

Mr. D. Seel: '*Some Implications of Unfavourable Incisor Relationships*'.

Mr. J. C. Stephenson and Mr. W. G. Selley: '*Routine for Early Management of Cleft Lip and Palate*'.

The following demonstration was open for inspection throughout the meeting:—

Mr. B. C. Leighton: '*Museum Specimens: Some Cases showing Extra Teeth*'.

Saturday, 15 April

9.15 a.m. Paper: Mr. B. H. Miller: '*Lower Incisor Crowding in Treated Angle Class II, Division 1 Occlusions*'.

9.45 a.m. Paper: Mr. R. H. Birch and Mr. D. G. Huggins: '*Occlusal Disharmony in*

Untreated and Treated Patients with Class II, Division 1 Incisor Relationship’.

10.45 a.m. Coffee.

11.00 a.m. Paper: Mr. A. M. Cookson: ‘*Tongue Resting Position*’.

11.30 a.m. Paper: Mr. J. C. Ritchie: ‘*The Orthodontic Scene in Australia and New Zealand*’.

Closure of the Meeting and Induction of the New President

The PRESIDENT said that his year of office was an experience that he would not have liked to miss, especially as it provided the opportunity of meeting and getting to know more members of the Society. One also learned to appreciate the work done for the Society by its officers. A very great deal was owed to these devoted people. Mr. Rose was not merely Treasurer, but did a great many other things as well, and Dr. Mills, the Editor, was also constantly at work. (Applause)

It had been a very successful meeting and an enormous amount was owed to Mr. Nicol in this respect. Quite apart from the actual work, the Meeting had benefited very much from Mr. Nicol’s good relationship with his other colleagues in the University. The warmth of the welcome had been largely due to his reputation in Bristol. (Applause)

Finally, a very big ‘thank you’ was due to the Secretary, who had not been at all well lately and should not really have been here. Mrs. Campbell had also helped out considerably in various ways. (Applause)

The induction of the new President, Mr. J. S. Beresford, then took place and he was invested with the Jewel of Office.

The President (Mr. J. S. Beresford) expressed his personal thanks to the retiring President, to whom a formal vote of thanks had been proposed, by Professor C. F. Ballard, at the Annual Dinner. The meeting closed at 12.10 p.m.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and
Income and Expenditure Sheet
FOR THE 15 MONTHS
1 OCTOBER, 1965, TO 31 DECEMBER, 1966

COLE, DICKIN & HILLS,
CHARTERED ACCOUNTANTS, AUDITORS
18, Essex Street, Strand, London, W.C.2

INCOME AND EXPENDITURE ACCOUNT for the 15 months 1st October, 1965 to 31st December, 1966

[illegible]

BALANCE SHEET as at 31st December, 1966

We have prepared the above Balance Sheet and Accounts from the books, records and information given to us and we certify them to be in accordance therewith.

We have verified the investments and cash at Bank.

18, Essex Street, Strand, London, W.C.2.

3rd February, 1967

COLE, DICKIN & HILLS
Chartered Accountants

We have prepared the above Balance Sheet and Accounts from the books, records and information given to us and we certify them to be in accordance therewith.
We have verified the investments and cash at Bank.
18, Essex Street, Strand, London, W.C.2.
3rd February, 1967

COLE, DICKIN & HILLS
Chartered Accountants

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